2007 BIENNIAL REPORT ON THE CALIFORNIA MARINE INVASIVE SPECIES PROGRAM

PRODUCED FOR THE
CALIFORNIA STATE LEGISLATURE

By
M. Falkner, L. Takata, S. Gilmore, and N. Dobroski
California State Lands Commission
Marine Facilities Division
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I. EXECUTIVE SUMMARY

The Marine Invasive Species Act (Act) of 2003 revised and expanded the Ballast Water Management for Control of Nonindigenous Species Act of 1999 to more effectively address the nonindigenous species (NIS) threat. The Act charged the California State Lands Commission (CSLC) with oversight of the state's program to prevent or minimize the introduction of NIS from commercial vessels. To advance this goal, CSLC utilizes a comprehensive, multi-pronged approach that includes: ballast water management tracking, compliance, and enforcement; sound policy development in consultation with a wide array of experts and stakeholders; applied research that advances the strategies for NIS prevention; and outreach and education to bridge the knowledge gaps between scientists, legislators, and stakeholders. This report summarizes the activities and accomplishments in each of these areas from January 2004 through June 2006.

Upon departure from each port or place in California, vessels are required to submit a Ballast Water Reporting Form which details their ballast management practices. Since 2004, over 25,000 reporting forms have been submitted to CSLC. In order to verify that vessels have submitted reporting forms, received forms are matched with arrival data from the State's Marine Exchanges. Compliance with the requirement to submit this form consistently exceeds 90%. Late and missing form notifications are sent monthly to agents that represent the negligent vessels. Enforcement action is initiated for ship agents and vessel owners/operators that repeatedly fail to submit the required forms.

Compliance rates with ballast water management requirements in California are extremely high. During the period covered by this report, 99% of all vessel-reported ballast water carried into state waters complied with management requirements; either through complete retention of ballast onboard or undergoing a legal exchange prior to discharge. The majority (35% on average) of non-compliant ballast water discharged between January 2004 and June 2006 originated from Mexican coastal waters, with tank vessels and bulk carriers responsible for almost all (approximately 89%) of these discharges. The second largest proportion (28% on average) of noncompliant ballast water discharges originated within the U.S. West Coast Exclusive Economic Zone

(EEZ). While the majority of these vessels did conduct an exchange, the location of those exchanges did not meet the requirements of the Act. It is important to note, that while these improper exchanges are in violation of the ballast water management requirements, exchanged and subsequently discharged ballast water poses a significantly lower risk of NIS introduction than the discharge of unexchanged ballast water.

Beginning March 22, 2006, vessels operating within the Pacific Coast Region (i.e. coastal voyages) were required to manage their ballast water, either through retention or by conducting an exchange in near-coastal waters. The data show a recent increase in noncompliant discharges (from 9% in 2004 to 17% in the first half of 2006) which can be largely explained by these newly regulated coastal voyages. A similar pattern of non-compliance was seen during the first several months of the State's Program in 2000. Compliance has steadily improved since 2000 due to targeted outreach and education towards vessels found to be out of compliance, coupled with enforcement action on repeat offenders. CSLC staff expect to see a similar improvement in compliance among these newly regulated coastal vessels in response to increased outreach and education efforts. For repeat violators, CSLC staff have begun taking the first steps toward enforcement action. Warning letters are being sent to vessel owner/operators found to have violated the management requirements, and any subsequent violations will result in the pursuit of civil penalties by CSLC.

Vessel inspections conducted by CSLC staff verified high compliance with vessel-reported ballast water management. Between January 2004 and June 2006, 4013 inspections were conducted. Of those inspections, two percent of the vessels were in violation of the operational aspects of the law, which includes improper ballast water management. Vessels found to have violated the law are cited at the time of the inspection and a letter detailing the violation(s), including any necessary corrective actions, is forwarded to the vessel owner/operator. Vessels are re-inspected upon their next visit to state waters to ensure corrective actions have been taken. To more effectively address these violations, CSLC intends to increase vessel inspection

coverage. A budget change proposal beginning fiscal year 2007-2008 has been submitted to the Department of Finance requesting additional inspection staff to increase vessel inspection coverage.

CSLC completed several legislative reports during the past two and a half years. These reports offered policymaking guidance on commercial vessel NIS issues including: “Report on Commercial Vessel Fouling in California, Analysis, Evaluation, and Recommendations to Reduce Nonindigenous Species Release from the Non-Ballast Water Vector” (2006); “Report on Performance Standards for Ballast Water Discharges in California Waters” (2006); and “Report on the California Marine Invasive Species Program” (2005). These efforts have resulted in the development of regulations to stem the transport of NIS in the ballast water of vessels operating with the Pacific Coast Region and legislation directing CSLC to adopt regulations on performance standards for ballast water discharges.

As part of its philosophy of proactive, forward-looking management, CSLC strives to move the field of ballast water management forward, addressing gaps that will improve the ability of the program to prevent NIS introductions. The program has funded and facilitated numerous research projects that address high priority management challenges including: the evaluation and testing of experimental ballast water treatment technologies onboard operational commercial ships; the evaluation of the efficacy of ballast water exchange; the characterization of biota found in ballast water tanks; and an assessment of the risk of NIS introductions via commercial vessel fouling.

CSLC plays an advisory role and/or is an actively participating member of several organizations that address ship-born NIS issues. Staff participates in activities with the West Coast Ballast Outreach Project Advisory Committee, California Sea Grant Extension Program; Oregon’s Ballast Water Management Task Force; Aquatic Nuisance Species Task Force; and the Pacific Ballast Water Working Group. Additionally, Staff have convened or received special invitation to participate in several

workshops and have given presentations at numerous national and international meetings to build dialogues with professionals across a wide range of disciplines.

In the coming years CSLC will be: (1) developing regulations that implement our recommended performance standards; (2) resetting the fee for the Marine Invasive Species Control Fund (Fee) to reflect the needs of the expanding Program; (3) developing protocols for the independent review and evaluation of ballast water treatment technologies; and (4) reviewing existing treatment technologies as they relate to the performance standards. The focus of the CSLC Program will continue to be on protection, prevention, outreach and education, and solution-based actions. CSLC will continue to concentrate our available resources on working proactively with the regulated industry to achieve a high rate of compliance with required management practices, to minimize discharges of unmanaged water, and to reduce the risks of biological invasions.

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III. ABBREVIATIONS

Act	Marine Invasive Species Act (AB 433)
BOE	Board of Equalization
BW	Ballast Water
BWE(v)	Ballast Water Exchange (Verification)
BWT	Ballast Water Treatment
CCR	California Code of Regulations
CSLC	California State Lands Commission
CDFG	California Department of Fish and Game
CDOM	Chromophoric Dissolved Organic Matter
EEZ	United States Exclusive Economic Zone
EPA	Environmental Protection Agency
ETV	Environmental Technology Verification
Fund	Kapiloff Land Bank Fund
IMO	International Maritime Organization
MISP	Marine Invasive Species Program
LA-LB	Los Angeles-Long Beach Port Complex
MT	Metric Tons
NIS	Nonindigenous Species
NM	Nautical Miles
NOBOB	No Ballast on Board
OSPR	Office of Oil Spill Prevention and Response
PCR	Pacific Coast Region
PPT	Parts Per Thousand
PRC	Public Resources Code
QV	Qualifying Voyage
SERC	Smithsonian Environmental Research Center
STEP	Shipboard Treatment Evaluation Program
SWRCB	State Water Resources Control Board
TAG	Technical Advisory Group
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
WSA	Wetted Surface Area

IV. INTRODUCTION

Legislative Background and Report Purpose

Nonindigenous species (NIS) are organisms that have been transported by human activities to a region where they did not occur historically and have established reproducing populations in the wild (Carlton 2001). Once established, NIS can have serious negative human health, economic, and environmental impacts in their new environment. The ballast water of ships is considered one of the major mechanisms (vectors) through which foreign species are introduced to marine and estuarine habitats (National Research Council 1996).

In response to the threats posed by NIS, the California Legislature passed Assembly Bill (AB) 703, the Ballast Water Management for Control of Nonindigenous Species Act, in 1999. The law required that vessels originating from outside the 200 nautical mile Exclusive Economic Zone (EEZ) of the United States carry out mid-ocean exchange, or use an approved ballast water treatment method, before discharging ballast in California state waters. As mandated by AB 703, the California State Lands Commission (CSLC) established the California Ballast Water Management Program and was tasked with several specific responsibilities:

- Receive and process ballast management reports submitted by all vessels arriving to California State waters from outside the EEZ.
- Monitor ballast management and discharge activities of vessels through submitted reports.
- Inspect and sample vessels for compliance with the law.
- Assess vessel reporting rates and compliance with the law.

The activities and analyses of the first 2.5 years of the program (January 2000 through June 2002) are detailed in the first biennial “Report on the California Ballast Water Management Program” (Falkner 2003).

In recognition of the uncertainties surrounding the development of an effective ballast water management program for the State, AB 703 specified a sunset date of January 1, 2004. During the 2003 Legislative session, the act was revised and recast as AB 433, the Marine Invasive Species Act (Act). In the new Act, the ballast management requirements for vessels originating from outside of the EEZ remained largely similar to those of AB 703, with the exception that vessels engaged in coastwise crude oil trade were no longer exempted from the law.

Several recommendations identified during the administration of AB 703 and detailed in the program's first biennial report (Falkner 2003) were incorporated into AB 433. In accordance with the Act, the State program was renamed the Marine Invasive Species Program (MISP) and charged with several expanded responsibilities, including authorization to:

- Pursue criminal and/or civil penalties for violations to the law.
- Adopt ballast water management regulations for vessels originating from within the Pacific Coast Region (PCR) (Cooks Inlet, AK to ¾ down the Baja Peninsula and 200 nm offshore, excluding the Gulf of California).
- Adopt regulations for the evaluation and approval of experimental shipboard ballast treatment systems.
- Sponsor a pilot program to evaluate the feasibility of ballast water treatment technologies.
- Recommend performance standards for ballast treatment systems, in consultation with an advisory panel.
- Evaluate the risk of non-ballast ship-based vectors for spreading NIS, and recommend actions to prevent associated introductions, in consultation with an advisory panel.

The second biennial "Report on the California Marine Invasive Species Program" details the activities and analyses of the program from January 2003 through December 2004 (Falkner et al. 2005). Comparison of data between years 2003 and 2004 is cautioned in

that report because the data pertaining to 2003 reflects the requirements of AB 703, whereas 2004 data reflects the expanded requirements as mandated under AB 433.

The purpose of the current report is to summarize MISP activities and analyses during the first 2.5 years of AB 433, January 1, 2004, through June 2006. As mandated, this report includes an analysis of ballast practices reported by the industry, summarizes NIS research completed, evaluates the effectiveness of the program, and puts forth recommendations to improve effectiveness of the program. In addition, this report describes the process through which MISP seeks input from research, stakeholder, and government communities to guide management recommendations and rulemaking in pursuit of preventing new vessel-borne introductions to the State of California.

Note that ballast water regulations pertaining to vessels engaged in coastwise trade within the Pacific Coast Region went into effect on March 22, 2006. This report will examine the behavior of coastal vessel traffic prior to and during the first few months after the coastal regulations took effect.

Vehicles of Introduction – "Shipping Vectors"

Also know as "introduced," "invasive," "exotic," "alien," or "aquatic nuisance species," nonindigenous species (NIS) in marine, estuarine and freshwater environments may be transported to new regions through numerous human activities: intentional and unintentional introductions of fish and shellfish, aquaculture, illegal releases from the aquarium and pet industries, floating marine debris, bait shipments, and accidental release through research institutions are just a few of the mechanisms, or vectors, by which organisms are introduced into U.S. waters (U.S. Commission on Ocean Policy 2004). In coastal environments, commercial shipping is the most important vector for invasion, in one study accounting for or contributing to 79.5% of introductions to North America (Fofonoff et al. 2003).

Commercial ships transport organisms through two primary mechanisms: ballast water and fouling. Ballast water is necessary for many functions related to the trim, stability,

maneuverability, and propulsion of large seagoing vessels (National Research Council 1996). Vessels may take on, discharge, or redistribute water during cargo loading and unloading, as they encounter rough seas, or as they transit through shallow coastal waterways. Typically, a vessel takes on ballast water after cargo is unloaded in one port to compensate for the weight imbalance, and will later discharge water when cargo is loaded in another. This transfer of ballast water from “source” to “destination” ports concomitantly results in the transfer of many organisms from one region to the next. In this fashion, it is estimated that some 7000 plus species are moved around the world on a daily basis (Carlton 1999).

Fouling organisms are aquatic species associated with hard surfaces. These include organisms that physically attach to vessel surfaces such as barnacles, algae, and mussels, and mobile organisms such as worms, juvenile crabs, and amphipods (small shrimp-like animals) that associate with fouling communities. Though much of the outer surface of vessel hulls is treated with toxic paints designed to discourage fouling growth, worn or unpainted areas, and areas protected from shear forces have been found to harbor fouling organisms (Coutts et al. 2003, Minchin and Gollasch 2003, Ruiz et al. 2005a). Vessels that spend long periods in port or move at slow speeds, such as barges and floating dry docks, appear to accumulate more extensive and diverse fouling communities (Godwin et al. 2004, Minchin and Gollasch 2003, Godwin 2003). In some circumstances, fouling organisms have been observed to be in spawning (reproductive) condition at arrival ports (Coutts et al. 2003, Apte et al. 2000).

NIS Impacts

The rate, and thus the risk, of species invasions has increased significantly during recent decades. In North America, the rate of reported invasions in marine and estuarine waters increased exponentially over the last 200 years (Ruiz et al. 2000a). In the San Francisco Bay Estuary alone, a new species is believed to become established every 14 weeks (Cohen and Carlton 1998). One of the primary factors leading to this increase was the vast expansion of global trade during the past 50 years which in turn lead to significantly more ballast water, fouled hulls, and associate organisms moving

around the world. Additionally, the increased speed of global trade has allowed many more potentially invasive organisms to survive better under decreased transit times (Ruiz and Carlton 2003). Organisms that arrive “healthy” in recipient regions are more likely to thrive and reproduce in their new habitats.

Once established, NIS can have severe ecological, economic, and human health impacts on the receiving environment. The most infamous example is the zebra mussel (*Dreissena polymorpha*), introduced to the Great Lakes from the Black Sea in the mid-1980s. Zebra mussels attach to hard surfaces in dense populations (as many as 700,000 per square meter) that clog municipal water systems and electric generating plants, resulting in costs of approximately a billion dollars a year (Pimentel et al. 2005). In such high densities, zebra mussels filter vast amounts of tiny floating plants and animals (plankton) from the water. Plankton support the foundations of aquatic food webs, and disruptions to this base appear to reverberate throughout the ecosystem. By dramatically reducing plankton concentrations and crowding out other species, zebra mussels have altered ecological communities, causing localized extirpation of native species (Martel et al. 2001) and declines in recreationally valuable fish species (Cohen and Weinstein 1998).

In San Francisco Bay, the overbite clam (*Corbula amurensis*) spread throughout the region’s waterways within two years of first being detected in 1986. The clam accounts for up to 95% of the living biomass in some shallow portions of the bay floor (Nichols et al. 1990). It has contributed to a persistent decline in the availability of plankton in the Sacramento-San Joaquin River Delta (Jassby et al. 2002) which, in turn, may be a cause of declines in fish populations (Feyrer et al. 2003). The Chinese mitten crab (*Eriocheir sinensis*) was first sighted in San Francisco Bay in 1992 and quickly spread through the system, clogging water pumping stations and riddling levies with burrows (Rudnick et al. 2000, Rudnick et al. 2005). Costs for control and research were $1 million in 2000-2001 (Carlton 2001). The European green crab (*Carcinus maenas*) thought to have caused the crash of the Maine softshell clam fishery, arrived in California during the mid-1990s (Grosholz and Ruiz 1995). There are fears that it will

compete for food with the valuable Dungeness crab (*Cancer magister*) threatening the west coast fishery (McDonald et al. 2001). The microorganisms that cause human cholera (Ruiz et al. 2000b) and paralytic shellfish poisoning (Hallegraeff 1998) have also been found in the water and sediments in ballast tanks.

In addition to the known impacts of established NIS, threats posed by species that may invade are significant and require constant monitoring. Though the zebra mussel is not yet established west of Oklahoma, it has been sighted on trailered boats in California (USGS 2005). Based on its habitat preferences, the mussel has the potential to colonize many California waterways including the California, Los Angeles and Colorado River Aqueducts (Cohen and Weinstein 1998). The Chinese Mitten Crab is a secondary host for the Asian lung fluke (*Paragonimus westermanii)* which is a known parasite of humans. Though as of 2000 no infected crabs have been found in California, there is significant risk of outbreak should the fluke, or an infected crab, arrive from overseas (California Sea Grant 2003).

Prevention through Ballast Water Management

Attempts to eradicate NIS after they have become widely distributed are often unsuccessful and costly (Carlton 2001). Between 2000 and 2006, over $7 million was spent to eradicate the Mediterranean green seaweed (*Caulerpa taxifolia)* from two small embayments (Agua Hedionda Lagoon and Huntington Harbour) in southern California (Woodfield 2006). Control is likewise extremely expensive. For example, approximately $10 million is spent annually to control the sea lamprey (*Petromyzon marinus*) in the Great Lakes (Lovell and Stone 2005). Over the past seven years, approximately $6 million has been spent to control Atlantic cordgrass (*Spartina alterniflora*) in San Francisco Bay, and another $3 million is needed over the next two years (M. Spellman, pers. comm. 2006). Prevention is therefore considered the most desirable way to address the NIS issue.

For the vast majority of commercial vessels, open-ocean ballast exchange more than 200 nautical miles (nm) offshore is the primary method of ballast water management.

Currently, it is the best compromise of efficacy, environmental safety, and economic practicality. The vast majority of vessels are capable of conducting exchange, and the management practice does not require any special structural modification to most vessels in operation.

During exchange, the biologically rich water that is loaded while a vessel is in port, or near the coast, is exchanged with the comparatively species-poor waters of the open ocean. Coastal organisms adapted to the conditions of bays, estuaries and shallow coasts are not expected to survive and/or be able to reproduce in the open ocean due to differences in biology and oceanography between the two regions (Cohen 1998). Open ocean organisms are likewise unable to survive in coastal waters. Scientific research indicates that offshore ballast exchange typically eliminates 70% - 98% of the organisms originally taken into a tank while at or near port (MacIsaac et al. 2002, Wonham et al. 2001, Zhang and Dickman 1999, Parsons 1998, Cohen 1998).

Ballast water exchange, however, is widely considered an interim ballast water management tool because of its variable efficiency and due to several operational limitations. New research demonstrates that the percentage of ballast water exchanged does not necessarily correlate with a proportional decrease in organism abundance (Bills et al. 2003, Choi et al. 2005). A proper exchange can take many hours to complete, and in some circumstances, may not be possible without compromising safety (i.e. adverse sea conditions, antiquated vessel design). Some vessels are regularly routed on short voyages, or voyages that remain within 50 nm of shore. In such cases, the exchange process may create a minor delay or require a vessel to deviate from the most direct route. In the future, vessels will utilize alternative ship-based or shore-based treatment systems that reduce organisms in ballast water as well as, or better than, open-ocean exchange. Alternative ballast water treatment technologies are described in more detail in Section VIII.

Regulations

International, U.S. federal and state regulations governing management of ballast water share several similar components. All allow ballast water exchange as an acceptable method of ballast water management, and many programs provide some type of exemption should a vessel or its crew become endangered by the exchange process. All accept approved alternative ballast water treatments in anticipation of the development of effective technologies. All but the International Maritime Organization (IMO) require the completion and submission of forms detailing ballast management and discharge practices.

International Regulations - The IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments in February of 2004, which becomes effective one year after ratification by 30 countries representing 35% of the world shipping tonnage (IMO 2006). As of September 30, 2006, six countries (Maldives, Spain, St. Kits and Nevis, Syrian Arabic Republic, Nigeria and Tuvalu), representing 0.62% of the world shipping tonnage, had signed the convention. The Convention requires vessels to conduct exchange at least 50 nm from shore in waters at least 200 meters (m) deep, though it is preferred exchange be conducted 200 nm offshore (IMO 2006). Following the year 2014, the convention specifies varying ballast management requirements and deadlines depending on vessel size and construction date. Vessels constructed before 2009 must manage ballast in a manner that is at least as effective as exchange, until 2014 or 2016 depending on vessel size. Thereafter, they must meet a stringent "Ballast Water Performance Standard" that specifies strict limits on the number of organisms permissible per unit of ballast water.

Canada, Australia & New Zealand - Canada adopted mandatory ballast water management regulations in 2006. Vessels arriving to Canadian ports with ballast originating from outside of Canadian waters must conduct exchange more than 200 nm from shore in at least 2000 m of water. Additionally, vessels transiting solely within 200 nm of land must conduct exchange at least 50 nm from shore at a minimum depth of 500 m. These requirements do not apply to vessels transiting exclusively within

Canadian waters or the waters of the Great Lakes (Transport Canada 2006). Australia requires ballast water exchange outside of the 12 nm Australian limit in waters greater than 200 m deep, and ballast water from “high risk” areas is prohibited (Australian Quarantine and Inspection Service 2005). Australia is currently implementing a new National System for the Prevention and Management of Marine Pest Incursions. This National System will work to create domestic ballast water regulations as well as some form of biofouling regulations or guidelines (Australia Department of Agriculture, Fisheries, and Forestry 2006). In New Zealand, vessels must conduct mid-ocean exchange in waters at least 200 nm offshore and must obtain permission before discharging, even if ballast water has been exchanged. Absolutely no discharge is allowed if vessels contain water from the “high risk” Australian ports of Tazmania and Port Philip Bay (New Zealand Ministry of Fisheries 2005).

Federal Regulations - In September of 2004, the United States Coast Guard adopted mandatory ballast water management regulations for vessels entering from outside the EEZ. Exchange is required to be conducted more than 200 nm offshore; however, vessels that experience undue delay are exempted. There is no management requirement for vessels traveling “coastally,” or wholly within the 200 nm EEZ.

Mainland U.S. Pacific Coast - With the exception of Alaska, all U.S mainland Pacific states have adopted ballast water management regulations that are more comprehensive than the federal requirements. Oregon began requiring ballast water management in 2002. Vessels of foreign origin are required to conduct exchange at least 200 nm offshore. Additionally, vessels traveling within 200 nm of shore and entering Oregon from areas north of 50° N, or south of 40° N must conduct exchange at least 50 nm from shore in at least 200 m of water (Simkanin and Sytsma 2006). Washington implemented exchange requirements identical to those in Oregon for foreign vessels in 2000. Coastally transiting vessels are required to conduct exchange at least 50 nm offshore, with the exception that exchange is not required if the ballast water is common to the state and has not been mixed with waters outside of the Columbia River system (Washington Department of Fish and Wildlife 2003).

California – In 1999, California passed Assembly Bill 703 (AB 703), the Ballast Water Management for Control of Nonindigenous Species Act, which established a statewide program to prevent species introductions and control NIS in state waters. AB 703 required vessels entering California waters from outside the U.S. EEZ to manage their ballast water before discharging. Vessels were required to exchange ballast water 200 nm offshore or use an approved shipboard or shore-based ballast water treatment system before discharging. The Legislature included a sunset date of January 1, 2004 in AB 703, and in 2003 Assembly Bill 433 was passed, reauthorizing and enhancing the 1999 legislation. In March 2006, regulations requiring the management of ballast water by vessels engaged in coastal trade went into effect. During the preparation of this report, Governor Arnold Schwarzenegger signed Senate Bill 497 (SB 497), the Coastal Ecosystems Protection Act, requiring CSLC to adopt regulations on performance standards for the discharge of ballast water by January 2008. More information on the development of recommendations for performance standards can be found in Section VIII of this report.

V. CALIFORNIA'S MARINE INVASIVE SPECIES PROGRAM

California's initial legislation, AB 703, addressed the ballast water invasion threat at a time when national regulations were not mandatory. The Ballast Water Management for Control of Nonindigenous Species Act, passed in 1999, established a statewide multi-agency program to prevent and control NIS in state waters. In addition to CSLC, the California Department of Fish and Game (CDFG), the State Water Resources Control Board (SWRCB) and the Board of Equalization (BOE) were charged to direct research, monitoring, policy development, and regulation, and to cooperatively consult with one another to address the problem (Falkner 2003). AB 703 required that vessels entering California from outside the EEZ manage ballast before discharging into state waters. Vessels were required to exchange ballast water 200 nm offshore or treat ballast water with an approved shipboard or shore-based treatment system. There was, however, no management requirement for vessels transiting between ports wholly within the EEZ, despite evidence that "intra-coastal" transfer may facilitate the spread of NIS from a

location where it is firmly established to an adjacent port where it is not (Lavoie et al. 1999, Cohen and Carlton 1995). The Legislature, sensitive to the uncertainties surrounding the development of an effective ballast water management program for the State, included a sunset date of January 1, 2004 in AB 703.

In 2003 Assembly Bill 433 was passed, reauthorizing and enhancing the 1999 legislation to include many of the recommendations of the program's first biennial report (Falkner 2003). The bill reauthorized, enhanced, and renamed the State's ballast water management program, creating the Marine Invasive Species Act. The Act applies to all U.S. and foreign vessels over 300 gross registered tons that arrive at a California port or place after operating outside of California waters. All vessels arriving at a California port or place must have a ballast water management plan and ballast tank logbook specific to the vessel. Each vessel is required to submit a ballast water reporting form upon departure from each port call in California detailing their ballast water management practices. The Act also directed CSLC to adopt regulations for vessels transiting within the Pacific Coast Region, which were finalized in March 2006 (Figure V.1).

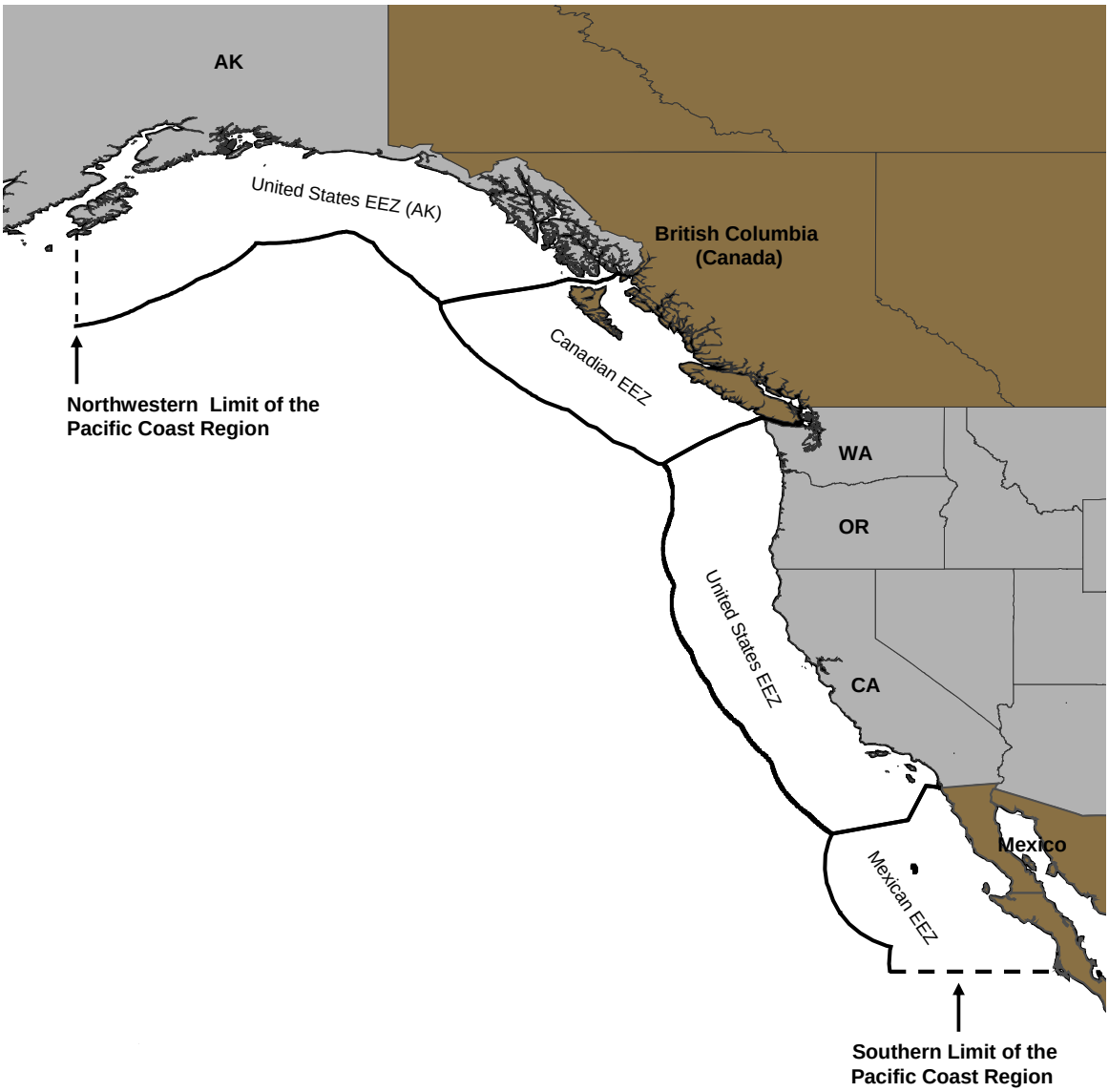

Figure V.1. Map showing the EEZs of Pacific North America and Mexico (200 nm), and the Pacific Coast Region. The PCR extends from approximately Cooks Inlet, AK (154° west longitude) to ¾ down the Baja Peninsula (25° north latitude) and 200 nm offshore.

To carry out the requirements of AB 433 and to ensure effective management, MISP is made up of several program components within the CSLC (Figure V.2). Functions include data management, field operations, administrative procedures, and public outreach activities. Data entry staff record ballast management data into a database system which is also used by both administrative and field operations staff. Administrative staff analyzes these data to develop policy recommendations and field staff use the database to record and target vessel inspections. Finally, all program components contribute to outreach activities in the form of technical advisory groups, dispersal of educational materials, and public outreach at national and international events.

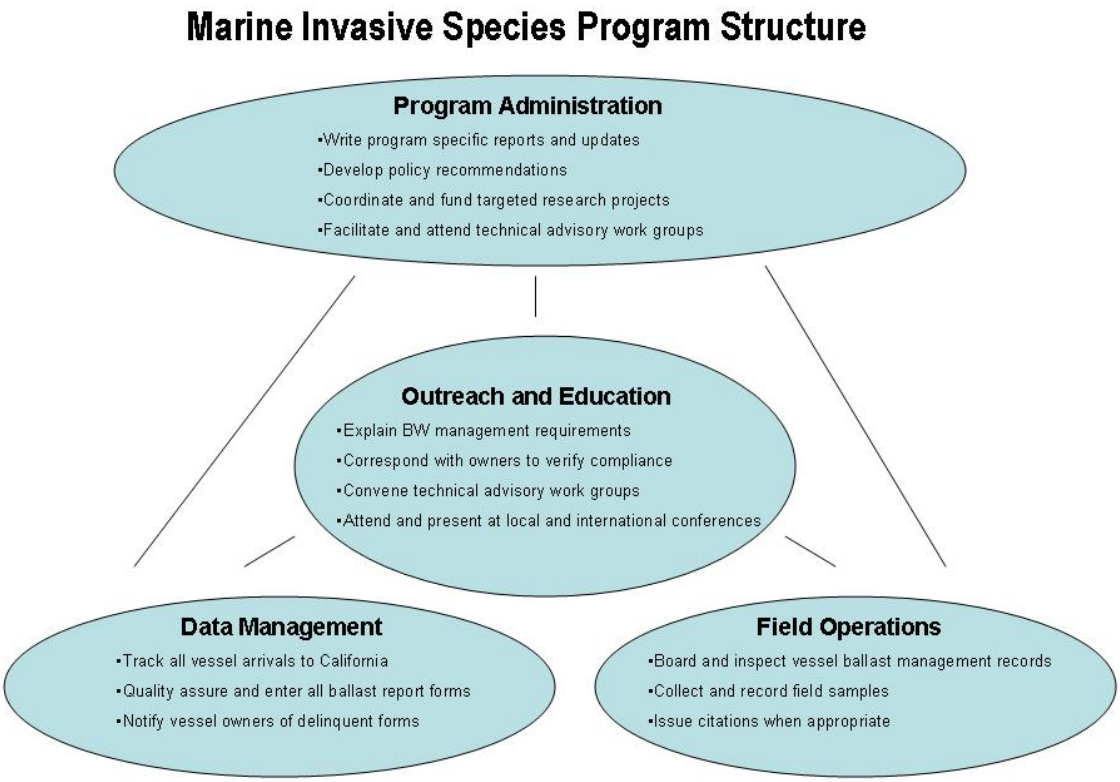

Figure V.2. Schematic model showing MISP components and associated functions

MISP data management staff track ballast water management, compliance and enforcement of more than 750 vessel arrivals every month. This involves the standardized, step-wise tracking of all vessel arrivals, reviewing ballast water management reports, identifying and clarifying inconsistencies, and the issuance of delinquency notices. In order to verify that vessels on qualifying voyages submit ballast water reporting forms, received forms are matched with arrival data from the Marine Exchanges. Late and missing form notifications are sent to agents representing vessels that neglect to submit forms. In 2005 and the first half of 2006, over 16,000 ballast water reporting forms were received, reviewed, entered into a database, and reconciled with actual port arrival data.

MISP field operations consist of field offices located in Northern and Southern California. CSLC vessel inspectors based at these field offices implement an extensive field monitoring program to ensure compliance with the law. Inspectors serve as an important, direct conduit of information to vessel crews, particularly in an industry where vessels frequently change ownership, routes, and crew composition. All vessels are required to submit to compliance inspections, which include sample collection of ballast water, examination of ballast water logbooks, engine books, report forms, and any additional inquiries as needed. The Act specifies that at least 25% of arriving vessels are to be inspected, with enforcement administered through the imposition of administrative civil and criminal penalties. During vessel visits, inspectors verbally explain paperwork, reporting, and ballast management obligations, and point out where a vessel may be falling short of compliance. Inspectors also sample ballast tanks when discharge is intended. The samples are analyzed for salinity (a measure of the salt concentration in water), which is currently the best available method to indicate if ballast water has been exchanged. Salinity levels are expected to indicate whether ballast water originated from coastal or mid-ocean areas because coastal regions tend to have more freshwater runoff. Coastal regions often exhibit lower salinities than open ocean water, which maintains an approximate reading of ~35 PPT (parts per thousand). When a violation is found, a citation is given to the vessel crew and a hard copy is retained in

CSLC files. A copy of the violation and enforcement letter is also sent to the vessel owner. The vessel is then targeted for re-inspection upon its next visit to California waters. The Commission finds that working with vessel owners in this way creates a positive working relationship with the industry that results in higher compliance rates.

In addition to verifying compliance with the management requirements of the Act, the Inspection Program plays a key role in MISP activities by providing vessel access for research projects, and outreach and education for the maritime industry. In 2001, inspectors provided vessel access to personnel from Dakota Technologies in order to collect ballast water samples for the development of a tool to verify proper ballast water exchange (BWE). In 2002-2003, inspectors assisted research scientists from San Francisco State University with the collection of ballast water samples from bulk carriers to evaluate the effectiveness of exchange on zooplankton populations (Choi et al. 2005).

MISP administrative staff work closely with a wide array of scientists, state and federal regulators, non-government organizations and the maritime industry to evaluate current knowledge and develop specific recommendations to guide policy. As a result of these collaborations, Staff coordinates research, develops regulations and policy recommendations, and completes legislative reports as required by the Act. Other functions of the administrative staff include the development and review of several NIS related environmental documents including: California Aquatic Invasive Species Plan (CDFG, In prep), Technical Issues for Testing and Evaluating Ballast Water Treatment Technologies (USCG, In prep), Alternative Ballast Water Exchange Areas (Pacific States Marine Fisheries Commission, In prep), and the Report on Ballast Water Management in Oregon (Simkanin and Sytsma 2006).

The administrative component of the Program coordinates and funds targeted applied research that advances the development of strategies for NIS prevention from the commercial ballast water and hull fouling vectors. Examples include: research to develop tools to verify ballast water exchange, needed for stronger enforcement;

demonstration, testing, and development of shipboard ballast water treatment technologies to reduce invasion risk; and investigation of fouling NIS on commercial vessel hulls arriving to the west coast.

One of the key components for the success of the Program continues to be the close communication, coordination, and outreach that occurs between CSLC, the maritime industry, and other state agencies. In general, outreach activities are designed to bridge the knowledge gaps between scientists, legislators, the regulated industry, non-government organizations and regulating agencies. Data management staff regularly corresponds with vessel owners to verify compliance with ballast water reporting requirements. Field staff interface with the industry on a regular basis to verify and educate crewmembers on ballast water management and reporting requirements. MISP administrative staff are active members in several ballast water related groups including: the West Coast Ballast Outreach Project Advisory Team, California Sea Grant Extension Program; Oregon's Ballast Water Management Task Force; Aquatic Nuisance Species Task Force; and the Pacific Ballast Water Working Group. Wherever possible, Staff work with the scientific community, other West Coast state representatives, Federal agencies, and the international maritime community to standardize ballast water management programs. This coordination and standardization has improved support and compliance by the maritime industry, and has encouraged knowledgeable cross-disciplinary input as policies are crafted.

As mentioned briefly above, the California Department of Fish and Game (CDFG), the State Water Resources Control Board (SWRCB) and the Board of Equalization (BOE) were charged to work cooperatively on the issue of ballast water NIS introductions in California. Assembly Bill 703 created the Exotic Species Control Fund to support each agency's program including the CSLC program components described above (Public Resources Codes (PRC) Section 71215). Reauthorization of the State's Program under AB 433 included the reauthorization and renaming of the Fund to the Marine Invasive Species Control Fund. CSLC continues to administer the fund in accordance with the Act. The Board of Equalization collects the fee for all qualifying voyages in California.

The budget also covers biological surveys conducted by CDFG to track the extent of NIS introductions in State waters. The State Water Resources Control Board serves a consultative role within the State Program.

In addition to the regulatory directives, the Act included mandates to address gaps identified during the beginning years of the MISP that would improve its ability to prevent NIS introductions. The MISP has formed several Technical Advisory Groups (TAGs) that discuss policy and regulatory matters related to general NIS management and the implementation of legislative mandates. TAGs include representatives from the maritime industry, ports, state and federal agencies, environmental organizations, and research institutions, and serve several critical outreach functions. They serve as a forum through which information and ideas can be exchanged, and ensure that rulemaking decisions consider the best available science as well as the concerns of affected stakeholders. TAG members also relay information to their respective constituencies, keeping them abreast of CSLC actions and activities.

VI. TRENDS IN STATEWIDE VESSEL TRAFFIC

Ballast Water Reporting Requirements

Under the Act, the master, owner, operator, agent, or person in charge of a vessel is required to submit a ballast water reporting form upon departure from each port or place of call in California. A qualifying voyage (QV) for purpose of reporting and Fee submittal includes all vessels greater than 300 gross registered tons operating in California waters. CSLC is required to compile the information obtained from submitted reports to assess shipping patterns and compliance with the requirements of the Act. Utilizing a state database created under AB 703, and modified as the law was reauthorized under AB 433, CSLC can assess: (1) rates of compliance with mandatory reporting and ballast water management requirements (see Section VII for Compliance statistics); and (2) patterns of ballast water delivery and management according to vessel class and geographic area. This information is assessed for both foreign and coastal (within the Pacific Coast Region) vessel traffic to California ports. As of March 22, 2006, vessels transiting solely within the Pacific Coast Region were required to manage their ballast

water. Due to the recent enactment of these coastal regulations, the available data on coastal ballast water management is limited at this time.

CSLC relies on three primary sources of data for assessment of the MISP. These include: (1) ballast water information reported directly to the CSLC by vessels operating in California waters; (2) transportation statistics collected from the two California Marine Exchanges, individual ports, and shipping agents; and (3) verification inspections of vessels operating in California waters conducted statewide by CSLC.

Reporting and ballast water management requirements are assessed at two different geographic scales: statewide and local port system. Under the original legislation (AB 703), CSLC identified 11 port zones, including San Diego, Los Angeles-Long Beach (LA-LB) complex, Hueneme, Redwood City, San Francisco, Oakland, Richmond, Carquinez, Stockton, Sacramento, and Humboldt. As a result of the Program's reauthorization, the development of coastal regulations, and an increase in commercial vessel traffic in California, CSLC has included an additional ten port zones: Avalon/Catalina, Camp Pendleton, Carpenteria, El Segundo, Monterey, Morro Bay, Moss Landing, and Santa Barbara (Figure VI.1).

Figure VI.1. Map of California port zones

Vessel Traffic Patterns

Based upon the information provided by vessels in the required ballast water reporting forms, CSLC calculates patterns of vessel traffic and ballast water management. Vessel traffic to California ports has continued to increase over the past six years (Figure VI.2).

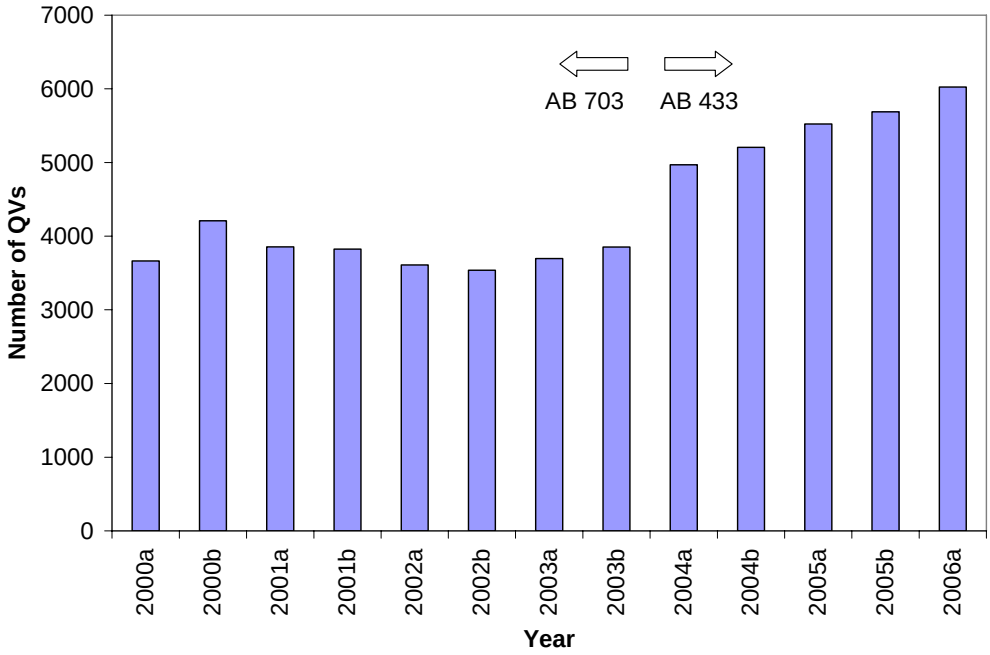

Figure VI.2. Number of qualifying voyage arrivals to California ports (a = January to June, b = July to December)

On a port by port basis, the LA-LB Port Complex continues to lead the state in QVs, for both foreign and coastal arrivals, although Oakland receives comparable numbers of coastal arrivals annually. Richmond and Carquinez have seen an increase in vessel traffic during 2005 and 2006, but overall, the pattern of vessel calls by port has changed little over the past two and a half years (Figure VI.3).

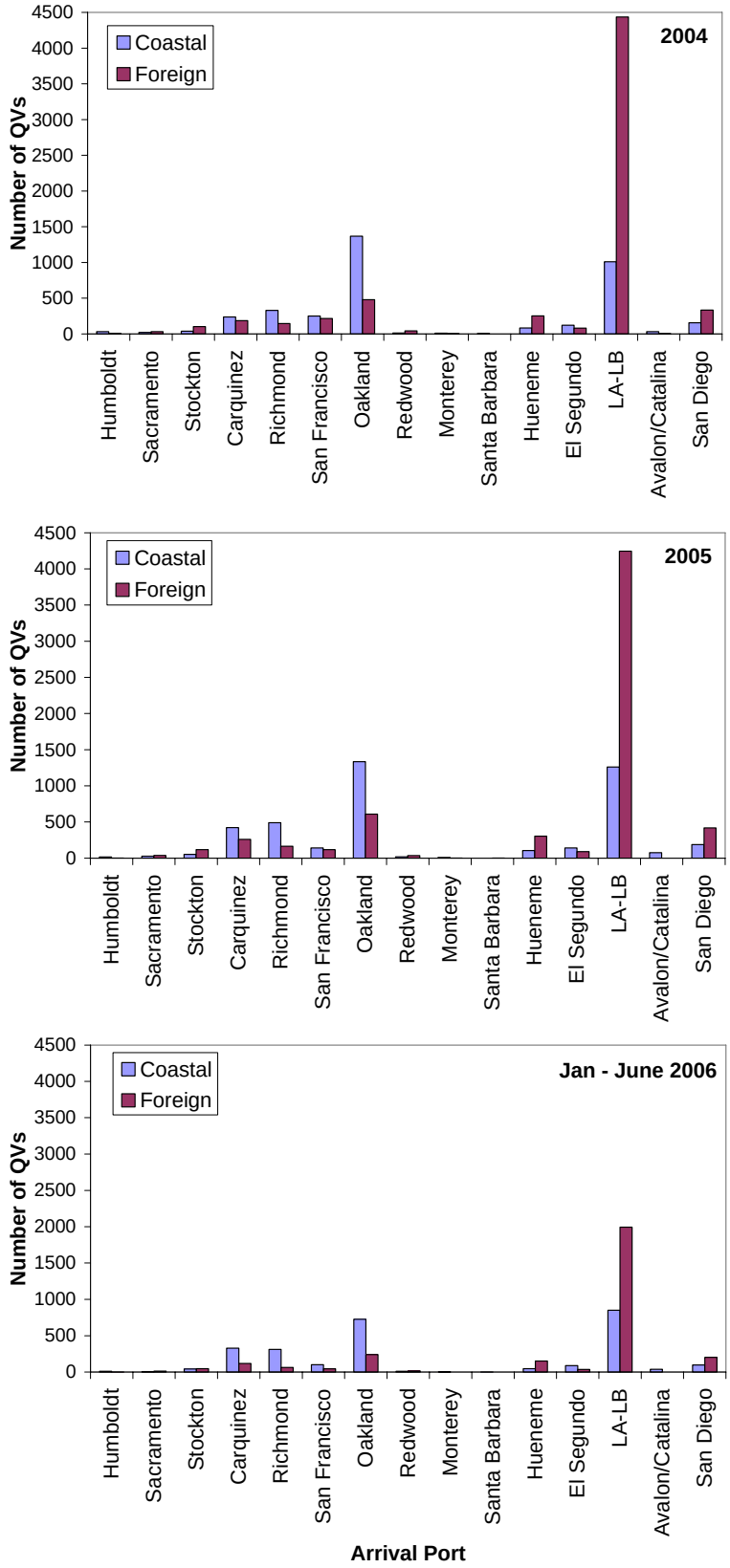

Figure VI.3. Qualifying voyage (QV) arrivals to California ports

Statewide, container vessels continue to dominate vessel calls (45% on average between 2004 and the first half of 2006), followed by tank vessels (19%), bulk (9%) and auto carriers (8%). Passenger vessels and general cargo carriers each account for roughly 7% of vessel traffic, and unmanned barges and other vessels make up the remaining traffic to California ports each year. LA-LB and Oakland receive the majority of container vessels. LA-LB also receives the majority of tank vessels, bulk carriers, and passenger vessels (Figure VI.4).

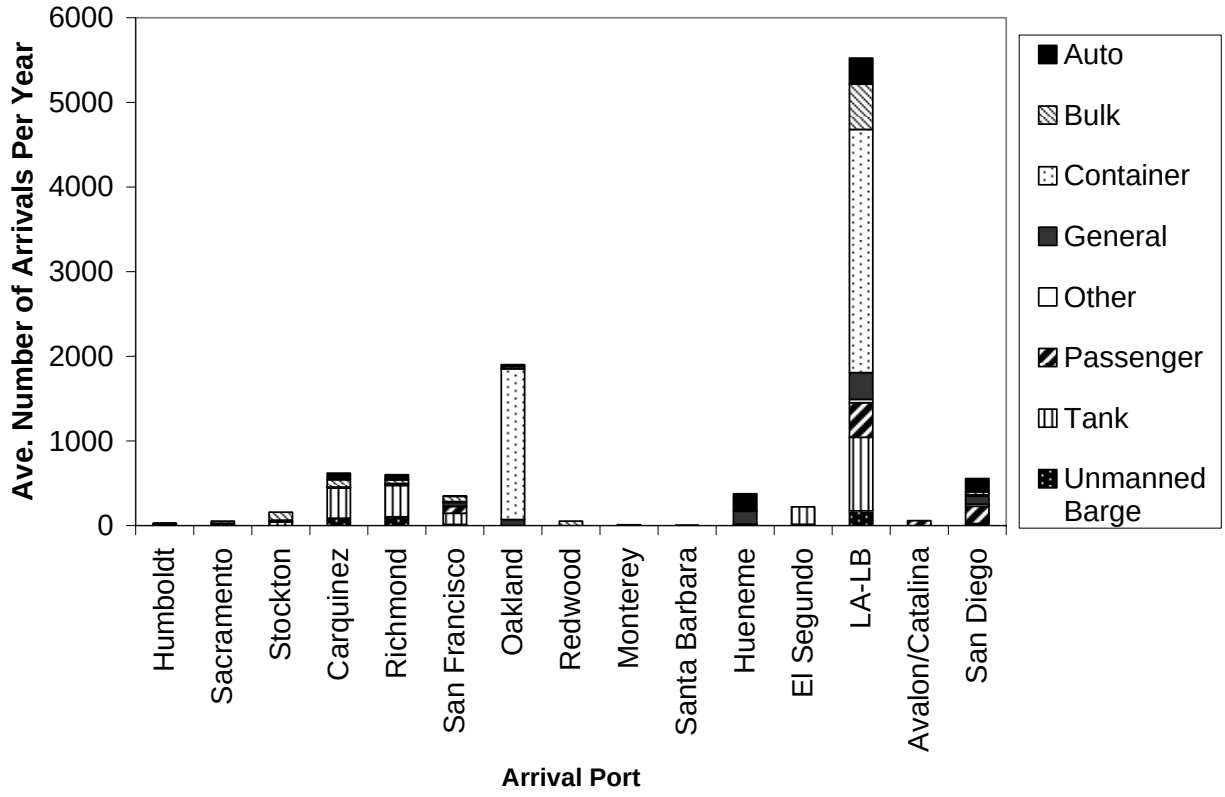

Figure VI.4. Average number of arrivals per year by vessel type and port (2004 – June, 2006)

Since 2004, over 50% of vessel calls to California ports originated from other west coast ports, the majority of which arrive from other California ports. Approximately one third (30%) of vessel arrivals to California originate from Asian ports, followed by approximately 10% from Mexican ports (Figure VI.5).

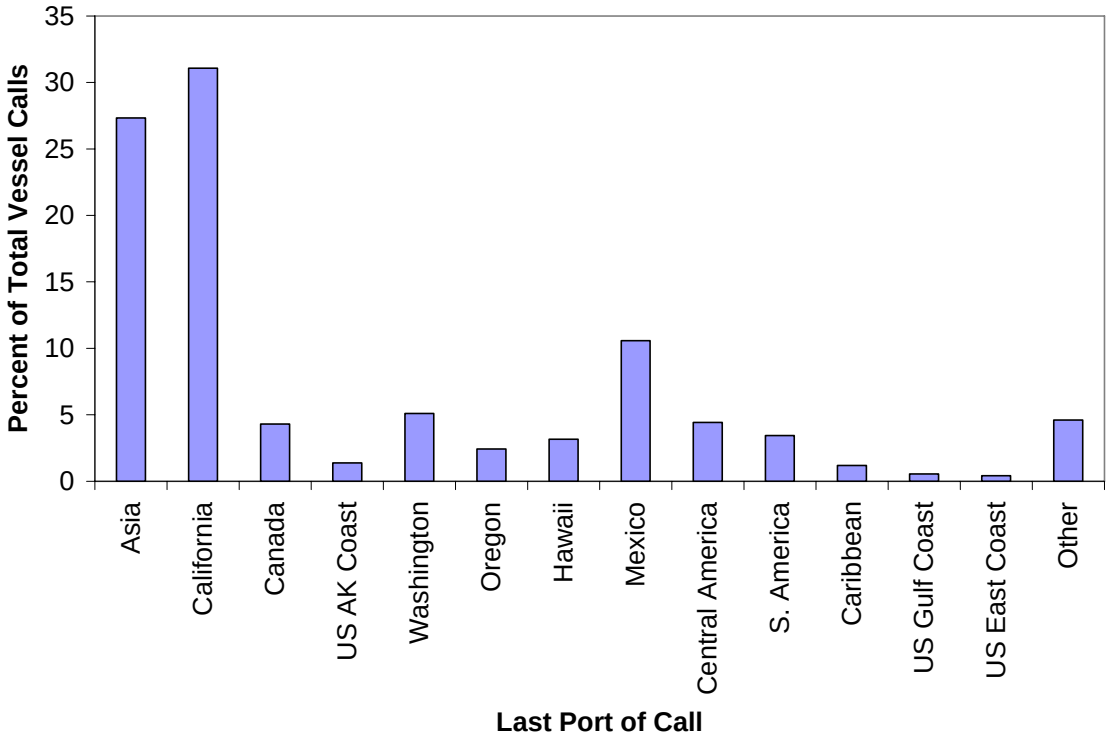

Figure VI.5. Average annual percent last port of call (2004 – June, 2006)

Ballast Water Discharge Patterns

The risk for NIS introductions through ballast water is based on many factors, including (but not limited to) the source, age, and volume of ballast water, environmental similarities between the source and recipient port waters, and time of year. Therefore, an examination of geographic and volumetric patterns of ballast water retention and discharge provides valuable background that may be used to frame relative risk and trends in risk related to the vector in the state.

Vessels that do not discharge any ballast water within the state pose no risk for NIS introductions through the vector, and retention is currently the most protective "management" available. Since reporting requirements were implemented in 2000, the annual percentage of vessels discharging ballast water has steadily decreased (Figure VI.6) to an overall average of 22% (Figure VI.7).

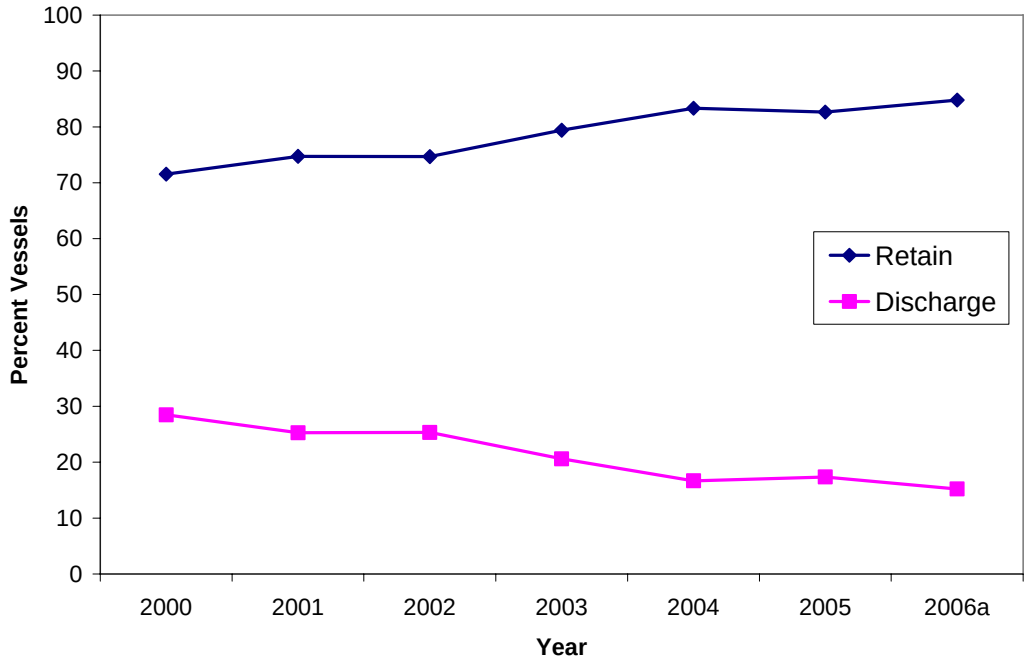

Figure VI.6. Reported ballast water management

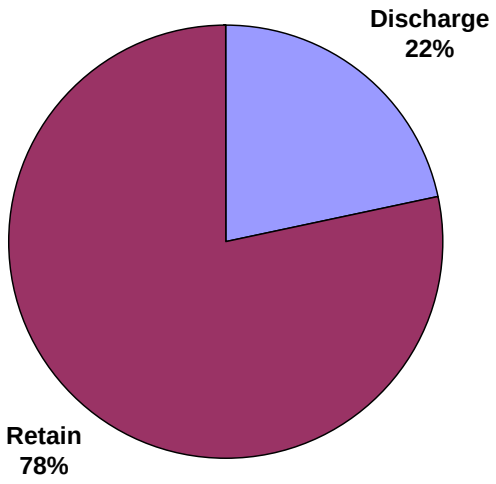

Figure VI.7. Average annual reported ballast water management (2000 – June, 2006)

While the overall percentage of vessels discharging has decreased (Figure VI.6), the volume of ballast water discharged over the same period has increased (Figure VI.8).

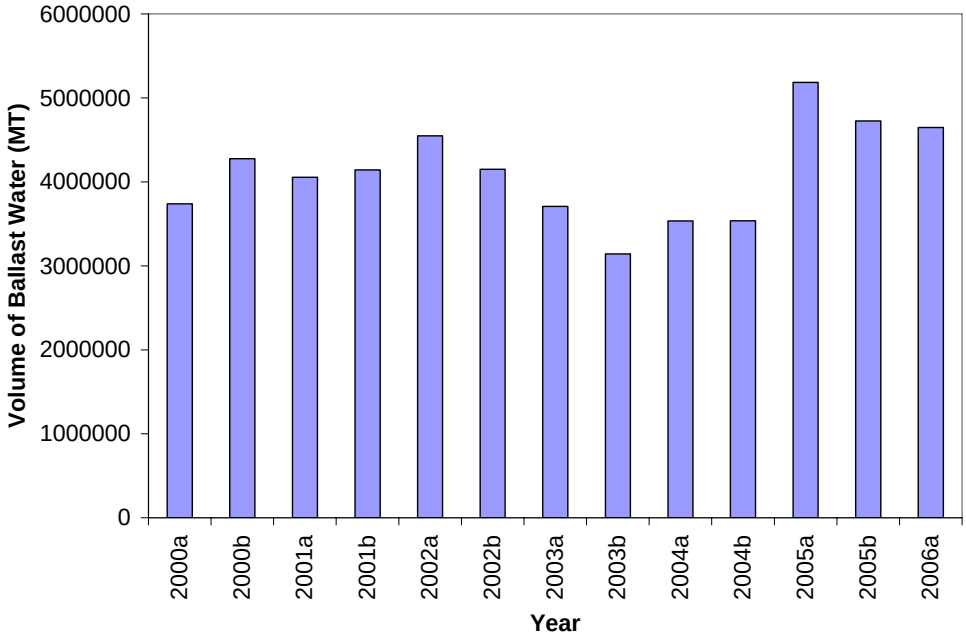

Figure VI.8. Total volume ballast water discharge (MT)
(a = January to June, b = July to December)

This increase is driven by bulk carriers and tank vessels (Figure VI.9), which are known to carry more ballast water than other ship types. Bulk vessels have an average ballast water capacity of 21,524 metric tons (MT). Tank vessels have an average capacity of 28,915 MT of ballast water, while container vessels are capable, on average, of holding only 13,641 MT of ballast water - less than half the capacity of tank vessels. Bulk and tank vessels combined account for only 28% of overall vessel calls to California ports each year, but they are responsible for 70 - 75% of the yearly volume of discharged ballast water. The recent increase in ballast water discharge can be explained, in part, by changes in the law. Prior to 2004, tank vessels engaged in the transport of domestic petroleum and unmanned barges operating exclusively within the US EEZ were not subject to the reporting requirements.

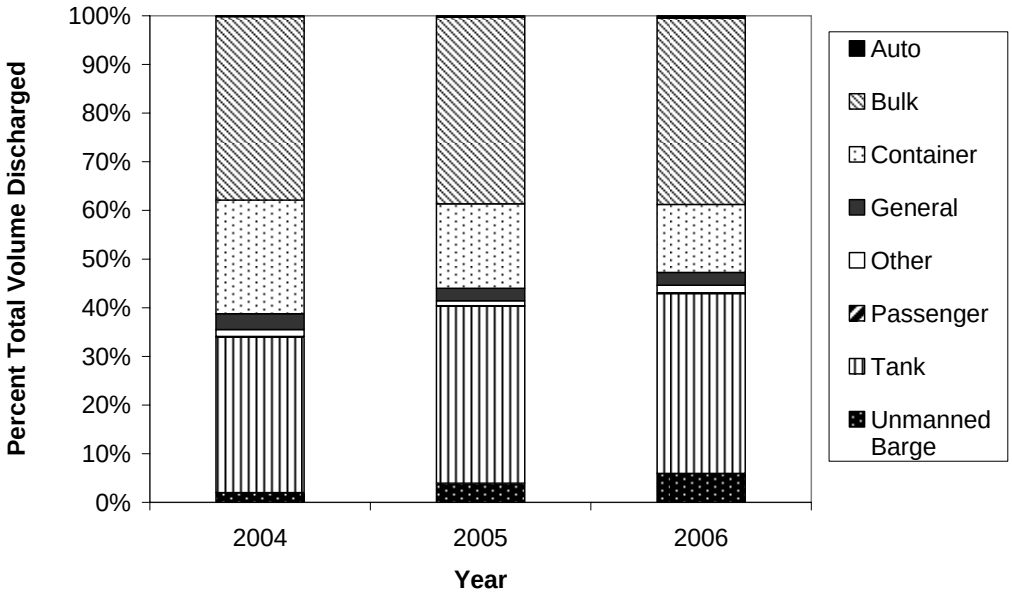

Figure VI.9. Percent discharge volume by vessel type and year

Though PRC Section 71204.2 aims to reduce NIS discharge via ballast water arriving from foreign places, it did not require ballast water management for vessels arriving from within the U.S. EEZ (though these vessels are required to submit ballast water reporting forms). As such, there remained the potential for established NIS to spread within the region. For example, a highly invaded area such as the San Francisco Bay could serve as a hub from which NIS can spread to adjacent areas, such as Humboldt Bay or the Los Angeles region. Indeed, a greater percentage of vessels originating from US West Coast ports discharge ballast water in California each year than vessels originating from foreign ports, and the percent of foreign vessels discharging in California has decreased steadily since 2004 (Figure VI.10).

A close examination of the number of vessels discharging by port highlights the regional nature of vessel discharge patterns (Table VI.1). Significantly more foreign vessels discharge in LA-LB than coastal vessels while the majority of vessels discharging in Oakland are of coastal origin. Two other ports found within the San Francisco Bay area, Carquinez and Richmond, also receive considerably more coastal vessels discharging than foreign vessels.

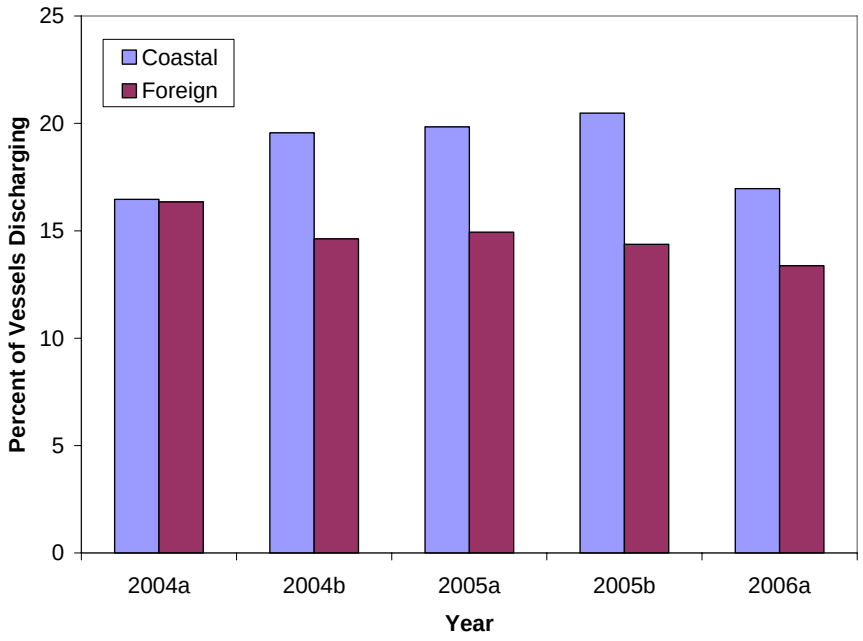

Figure VI.10. Foreign and coastal vessel discharge patterns

While the number of vessels discharging at each port (Table VI.1) is an indicator of potential risk of introduction, the volume of ballast water released at these ports is perhaps a better gauge of invasion pressure (Table VI.2). LA-LB received the greatest total volume of ballast water discharge each year, however in 2004 and the first half of 2006, Richmond and Carquinez, respectively, received a greater volume of water from coastal vessels than LA-LB. Ballast water discharged in Humboldt comes almost exclusively from coastal vessels (Table VI.2). This coastal water may carry species from highly invaded places such as San Francisco Bay. Overall, the combination of the quantity of arriving coastal vessels and large volumes of ballast water discharged by such transits (Tables VI.1 and VI.2) demonstrates the high potential for intraregional transport of introduced species across several recipient ports. In examining these statistics, it is important to note that several factors influence invasion risk in addition to the volume of ballast water released, including the age of the ballast water discharged (species often survive better when held for a short period of time), the degree of repeated inoculation (frequency with which ballast is discharged in a given area), and similarity between donor and recipient regions (biological, chemical, and physical characteristics at each port) (Carlton 1996, Ruiz and Carlton 2003).

Table VI.1. Number of Vessels Discharging by Port and Year

Discharge Port	2004		2005		2006	
	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign
Humboldt	12	2	10	0	8	0
Sacramento	5	20	9	18	1	7
Stockton	6	18	17	18	7	9
Carquinez	41	26	129	34	92	28
Richmond	114	12	148	19	73	6
San Francisco	49	16	37	9	13	7
Oakland	161	47	185	55	69	23
Redwood	3	6	4	9	5	6
Monterey	0	1	0	0	0	0
Santa Barbara	0	1	0	0	0	0
Hueneme	3	7	1	1	1	5
El Segundo	20	3	29	6	14	2
LA-LB	223	646	318	603	149	266
Avalon/Catalina	2	0	6	0	0	0
San Diego	16	8	38	16	21	16
TOTAL	**655**	**813**	**931**	**788**	**453**	**375**

Table VI.2. Discharge Volume (MT) by Port by Year.

Port	2004		2005		2006	
	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign
Humboldt	36368	14561	41024	0	12069	0
Sacramento	7764	198681	41312	110026	200	44407
Stockton	26159	150743	125350	169505	34137	126304
Carquinez	280580	219302	989173	382031	749176	410991
Richmond	1063283	103425	1310217	220012	582736	38591
San Francisco	241107	114279	246703	37961	63174	38439
Oakland	326040	130669	399566	171260	132126	87420
Redwood	28985	53258	50459	95113	30828	53471
Monterey	0	6	0	0	0	0
Santa Barbara	0	7300	0	0	0	0
Hueneme	2052	7816	2574	272	290	1380
El Segundo	51691	15455	194114	21858	84269	1167
LA-LB	962386	2984285	1507531	3414805	703352	1485004
Avalon/Catalina	24624	0	64851	0	0	0
San Diego	33412	7394	60686	19262	14396	17960
TOTAL	**3084452**	**4007175**	**5033560**	**4642103**	**2406751**	**2305135**

VII. COMPLIANCE

Utilizing the state database created under AB 703, and modified as the law was reauthorized under AB 433; CSLC can assess rates of compliance with reporting requirements and mandatory ballast water management guidelines.

As previously mentioned, under PRC Section 71205(a), the agent, along with the master, owner, operator, or person in charge is responsible for submitting the ballast water reporting form upon departure for each vessel call in California waters. With regards to mandated ballast water management requirements, prior to March 22, 2006 (implementation date of coastal regulations) a QV is nearly identical to those as defined under AB 703 and includes: (1) all arrivals to California waters from countries other than the United States; (2) arrivals to California from a U.S. island state or protectorate (e.g. Hawaii, Guam, and Puerto Rico), since they depart the EEZ during transit; (3) vessels that leave the Atlantic or Gulf of Mexico coasts, transverse the Panama Canal, and arrive in California; and (4) vessels that leave Alaskan ports and arrive in California, since they depart the EEZ during transit. AB 433 no longer exempts tank vessels engaged in coastwise trade from program reporting or ballast water management requirements.

Beginning March 22, 2006, subtle changes to the definition of a QV, with regards to ballast water management requirements, went into effect as a result of legislative mandates and the implementation of regulations governing ballast water management for vessels operating within the Pacific Coast Region. Under the new regulation, a QV for ballast water management purposes is categorized as any vessel over 300 gross registered tons operating in California. The Pacific Coast Region is defined as coastal waters on the Pacific Coast of North America east of 154 degrees W longitude and north of 25 degrees N latitude, exclusive of the Gulf of California (See Figure V.1).

Compliance with Ballast Water Reporting Form Submission

In late 2000, CSLC initiated an electronic notification procedure to notify ship agents and owners of missing forms. This electronic notification process, coupled with

education and outreach to the shipping industry, has resulted in high compliance with ballast water reporting requirements. Since 2004 (when reporting requirements changed in response to AB 433), reporting compliance has remained above 94%, with 85% percent of reports, on average, submitted on time. During the first half of 2006, 93% of QVs were compliant with reporting requirements, and 80% submitted reports on time (Figure VII.1).

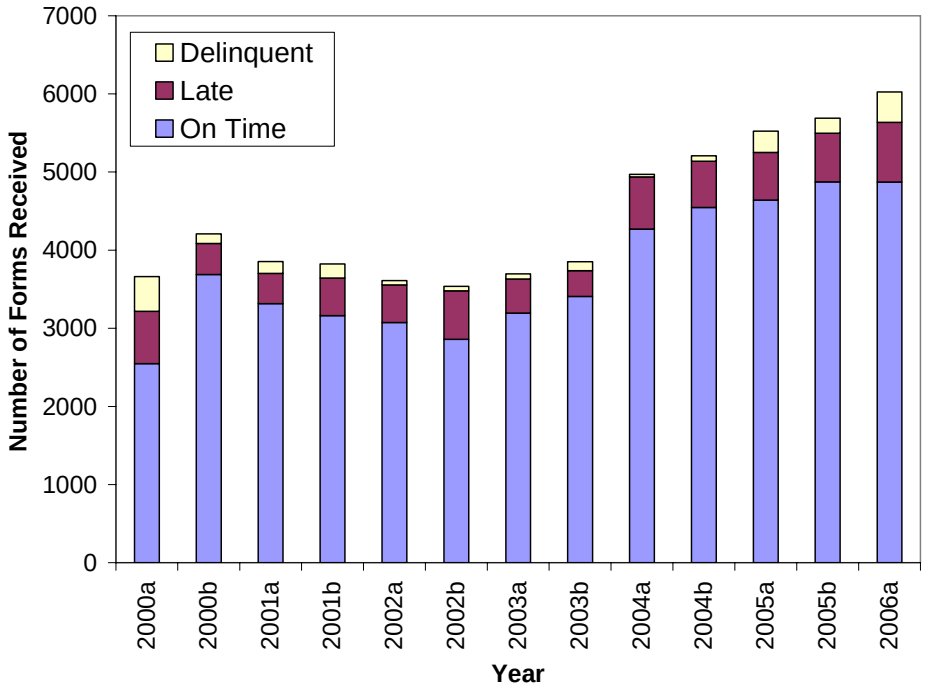

Figure VII.1. Ballast water reporting form compliance
(a = January to June, b = July to December)

Shipping agents are informed of impending enforcement action if reporting forms are more than 60-days delinquent (post mail and electronic notification). A lack of significant response to this warning on the part of the agent or vessel owner will initiate enforcement action including the potential for the levying of fines and/or other civil penalties.

Compliance with Ballast Water Management Requirements

Prior to March 22, 2006 Public Resources Code (PRC) Section 71204.2 requires that vessels arriving to the state from outside of the U.S. EEZ shall manage ballast water in one of five ways:

- Exchange ballast water in areas at least 200 nm from any shore and in waters at least 2000 meters deep (mid-ocean waters) before discharging in California waters.
- Retain all ballast water on board the vessel.
- Discharge ballast water at the same location where it was taken on, provided that the ballast water has not been mixed with water taken on in an area other than mid-ocean waters.
- Use an alternative, environmentally sound, CSLC or United States Coast Guard (USCG) approved method of treatment.
- Discharge the ballast water to an approved reception facility (currently there are no such facilities in California).

As a result of regulations regarding coastal voyages implemented March 22, 2006 ballast water management requirements changed. Per PRC Section 71204.3, vessels arriving to California ports from outside the Pacific Coast Region (Cooks Inlet, AK to ¾ down the Baja Peninsula and 200 nm offshore, excluding the Gulf of California) shall manage ballast water as described above. However, vessels operating within the Pacific Coast Region are required to manage their ballast water in the following ways:

- Exchange the vessel's ballast water in near-coastal waters, before entering the waters of the state, if that ballast water has been taken on in a port or place within the PCR.
- Retain all ballast water on board the vessel.
- Use an alternative, environmentally sound, CSLC or United States Coast Guard (USCG) approved method of treatment.

- Discharge the ballast water to an approved reception facility (currently there are no such facilities in California).

Two types of exchange methods are allowed under AB 433. Vessels utilizing the flow-through exchange method must pump three full volumes of mid-ocean water through the ballast tank. The empty-refill method requires that the ballast tank be emptied once, and subsequently refilled with mid-ocean water.

Overall, the combination of the quantity of arriving coastal vessels and large volumes of ballast water discharged by such transits (Tables VI.1 and VI.2) demonstrates the high potential for intraregional transport of introduced species across several recipient ports. In examining these statistics, it is important to note that several factors influence invasion risk in addition to the volume of ballast water released, including the age of the ballast water discharged (species often survive better when held for a short period of time), the degree of repeated inoculation (frequency with which ballast is discharged in a given area), and similarity between donor and recipient regions (biological, chemical, and physical characteristics at each port) (Carlton 1996, Ruiz and Carlton 2003).

Of the more than 250 million metric tons of vessel-reported ballast water carried into state waters between January 2004 and June 2006, 99% or 248 million metric tons complied with the California law. The most commonly utilized method of ballast water management is retention. During 2004 through June 2006, an average of 78% of the vessels that arrived to California did not discharge ballast water (an average of 8800 arrivals each year), and were compliant with state law. Of the ballast water that was discharged in the state, most had been appropriately managed through legal ballast water exchange, and was compliant with California law (Figure VII.2).

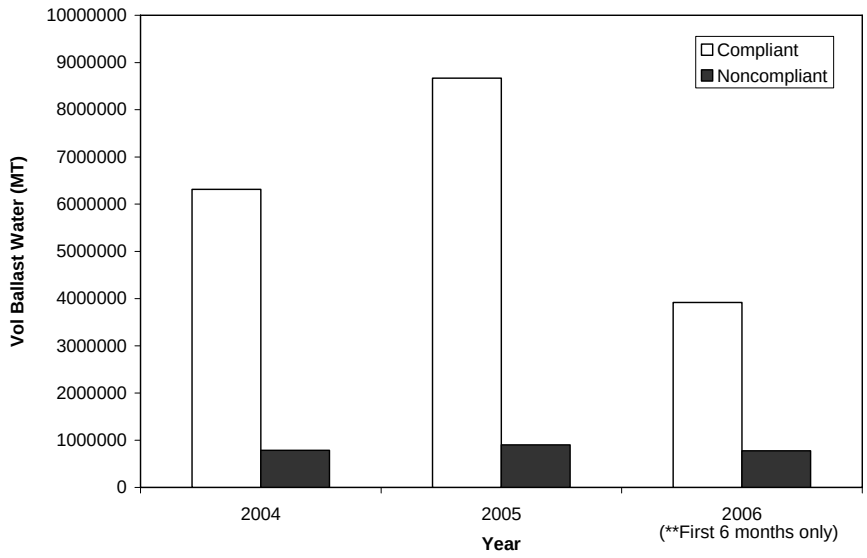

Figure VII.2. Volumes of compliant and noncompliant ballast water discharged by year. This includes only compliance of discharging vessels, and does not include statistics for vessels that comply by retaining ballast water. Note: 2006 includes only January through June.

On an annual basis, approximately 9-17% of all ballast water discharged in California was in violation of state law (dark bars depicted in Figure VII.2). The section that follows summarizes trends and patterns with regard to the subset of ballast water discharged in California that was not compliant with the state's laws from 2004 through the first six months of 2006 (dark bars depicted in Figure VII.2). It does not include statistics pertaining to the large proportion of vessels that comply with California law by retaining all ballast water.

Noncompliant ballast water discharged in California generally fell into three categories:

- Ballast water exchange was attempted, but the location of exchange was not in mid-ocean or in near coastal waters as required by PRC Sections 71204.2/71204.3 or by CCR Article 4.6 (Implemented 2006).
- Ballast water was not exchanged.
- Vessel reported exchanging ballast water, but the location of exchange was not specified.

While ballast water exchange at legal distances offshore are clearly most protective, some attempt at ballast water exchange is, in most cases, more beneficial than no exchange at all. Most vessels in violation with management requirements attempt to exchange before discharging in California, but do so in a location not acceptable by California law. This category accounted for 75% of noncompliant ballast water by volume in 2004 (189 vessels), 69% in 2005 (184 vessels), and 57% during the first six months of 2006 (104 vessels) (Figure VII.3). A very small proportion of vessels reported that ballast water had been exchanged, but it was unclear where exchange occurred because erroneous location information was provided (e.g. latitudes and longitudes fell on land).

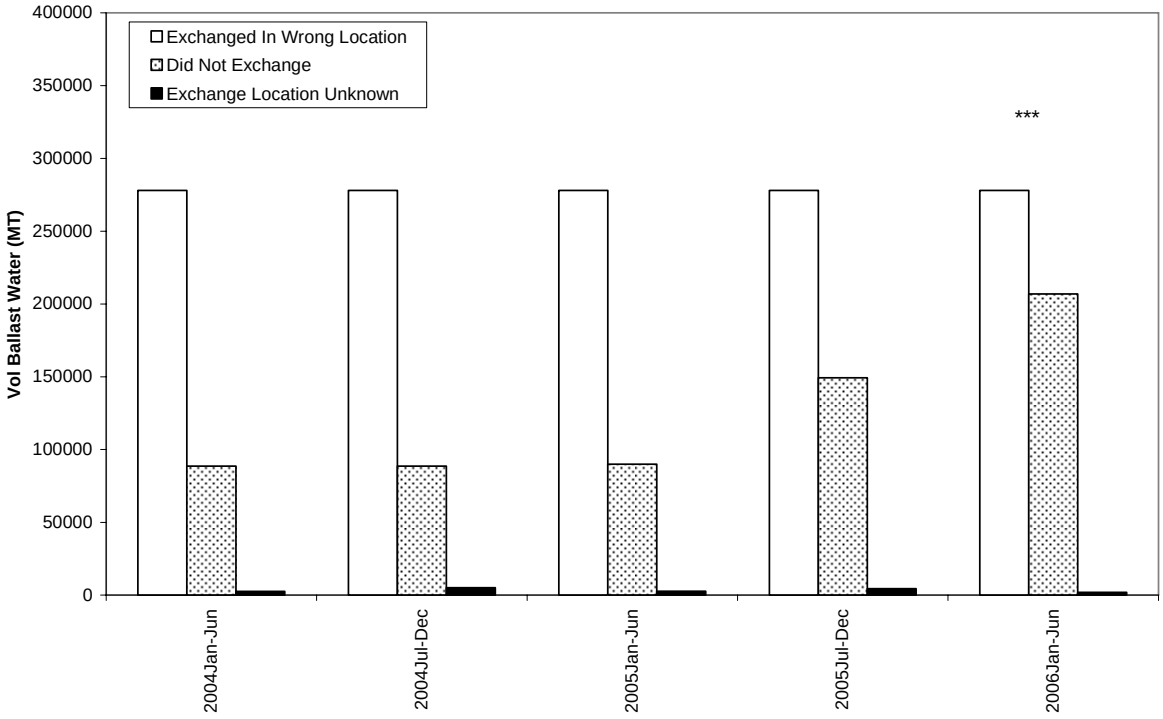

Figure VII.3. Volumes of noncompliant ballast water discharged by violation type. ***Note: New regulations governing ballast water management for vessels on coastal voyages went into effect on March 22, 2006.

While the volume of illegally exchanged ballast water remained steady throughout the examined period, a notable increase in the volume of unexchanged ballast water was

observed beginning in 2005. This is partially attributable to the implementation of the new regulation requiring ballast water management of vessels transiting within the Pacific Coast Region (Title 2 CCR Article 4.6, Implemented March 22, 2006). The number of arrivals with a last port of call of Oregon, Washington or California and completely neglected to exchange their ballast water jumped from 12 in 2005, to 29 in 2006. However, only 3.5 months of data following the implementation of the new rule was included in the current analysis. Future analyses that include a longer time series of data after the implementation of the rule will be conducted, and will show if compliance increases as more outreach is conducted and as violation citations are issued.

The increase in the volume of illegal, unexchanged ballast water during the latter half of 2005 was also largely driven by tank vessels and bulk carriers. Between the first and second half of 2005, tankers more than tripled the amount of ballast water discharged in this category, from approximately 11,000 MT (5 vessels) to 39,000 MT (6 vessels). By the first half of 2006, the amount of illegal, unexchanged ballast water discharged by tankers increased to approximately 77,000 MT (10 vessels). Between the second half of 2005 and the first half of 2006, the amount of ballast water discharged in this category by bulk carriers increased from approximately 1800 MT (1 vessel) to 34,000 MT (5 vessels).

The largest proportions of total noncompliant ballast water were attributable to three vessel types: containers, bulkers and tankers. Their relative contribution, however, shifted throughout the examined period. Though container vessels consistently accounted for the largest number of vessel visits to California (45%), the proportionate volumes of noncompliant ballast water discharged by them has steadily decreased from 25% (104 vessels) in 2004, to 23% (84 vessels) in 2005, to 9% (34 vessels) during the first six months of 2006. Most of the noncompliant ballast water (by volume) discharged was attributable to bulkers and tankers. This proportion has been increasing since 2004, up from 65% (92 vessels) in 2004, to 68% in 2005 (110 vessels), and 87% (78 vessels) during the first six months of 2006 (Figure VII.4).

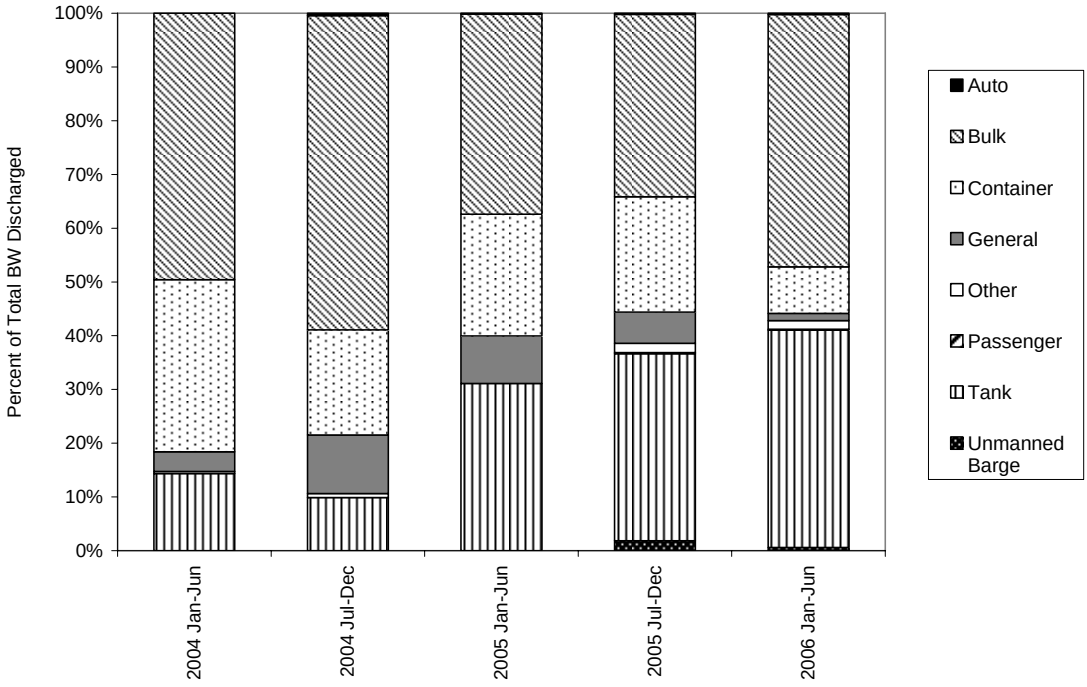

Figure VII.4. Proportions of noncompliant ballast water by vessel type

These trends mirror the increases in the number of visits by bulkers and tankers to California during recent years. They also underlie the important role of ballast water capacity in addition to the number of vessel visits, to ballast water management in the state.

Source of Noncompliant Ballast Water

During all years examined, the largest proportion of noncompliant foreign ballast water has consistently originated from Mexican waters (Figures VII.5 -VII.7). The vast majority of noncompliant Mexican ballast water was discharged by tankers and bulkers, accounting for 82% by volume in 2004, 86% in 2005, and 97% during the first 6 months of 2006.

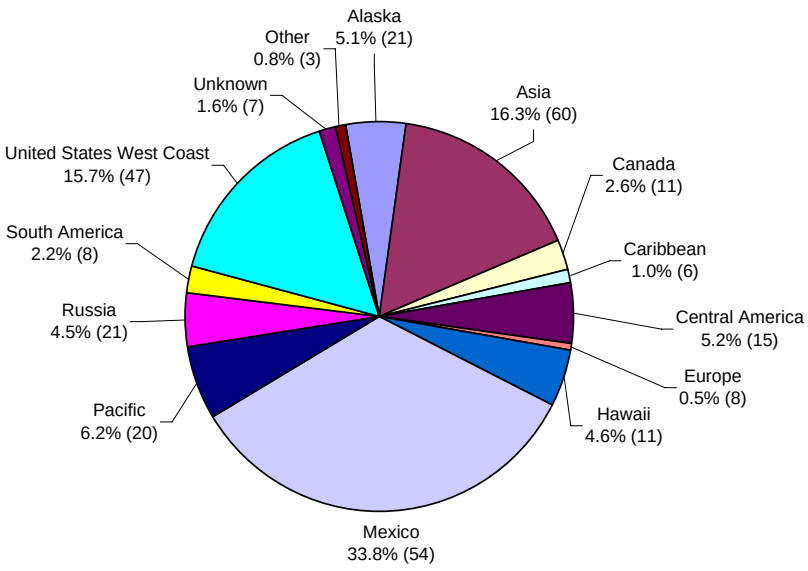

Figure VII.5. Source of noncompliant ballast water (2004). Numerals in parentheses denotes number of vessels

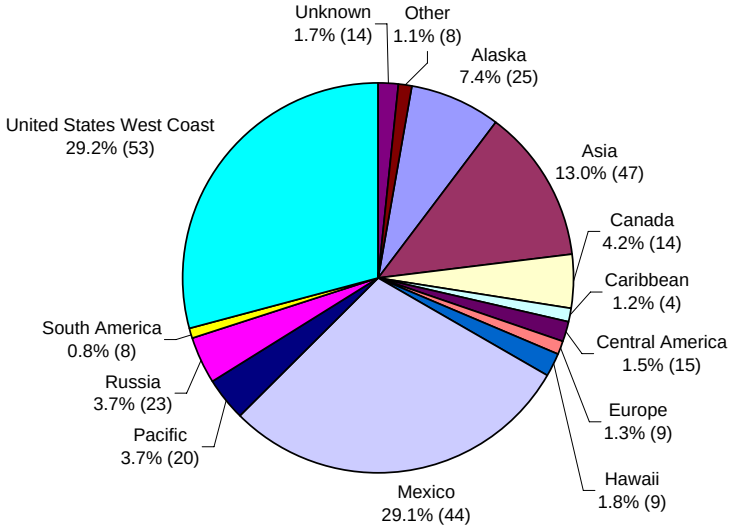

Figure VII.6. Source of noncompliant ballast water (2005). Numerals in parentheses denotes number of vessels.

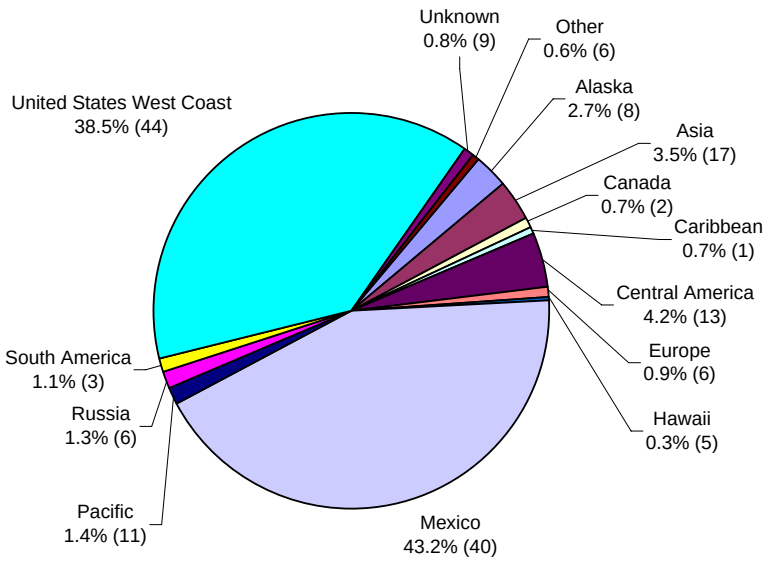

Figure VII.7. Source of noncompliant ballast water (Jan – June, 2006). Numerals in parentheses denotes number of vessels.

The second largest proportion of noncompliant ballast water originated within the United States West Coast EEZ (200 nm or closer to California, Oregon or Washington). Illegal ballast water can originate from within the EEZ when a vessel enters the U.S. EEZ and does not exchange its ballast water, or exchanges its ballast water within 200 nm of shore prior to discharging in California (illegally conducts exchange in the wrong location). After March 22, 2006, vessels that transit from the Pacific Coast Region and exchange less than 50nm from shore can also carry noncompliant ballast water from the U.S. West Coast EEZ. As with ballast water originating from Mexican waters, the majority of illegal ballast water originating from within the United States West Coast EEZ was attributable to tankers and bulkers (38% and 26% respectively in 2004, 57% and 25% respectively in 2005, 53% and 38% respectively during the first six months of 2006). As noted earlier in this section, the increase in the total proportion of noncompliant ballast water from the U.S. West Coast during 2006 is partially attributable to the initiation of the Pacific Coast Region regulation, since vessels on some coastal voyages that had not been required to manage ballast water previously (e.g. between Los Angeles and San Francisco Bay) were required to do so after March 22.

In all years, Asian ballast water illegally discharged in California was nearly entirely attributable to container and bulk vessels (95-98%). Also across all years, most vessels with Asian ballast water attempted to exchange (70-77%), but did so in a location within an Asian EEZ (in the wrong location).

Since 2004, over 25,000 reporting forms have been submitted to CSLC. Compliance with the requirement to submit this form consistently exceeds 90%. While there has been an increase in the volume of noncompliant ballast water discharged in California during the time covered by this report, it is important to note that of the more than 250 million metric tons of ballast water carried into California waters, just under 1% did not comply with management requirements. Furthermore, the vast majority of the noncompliant ballast water discharged in state water's underwent some type of exchange, reducing the risk of NIS introductions.

Though total volumes of noncompliant ballast water discharged in California appears to be increasing, the proportionate number of vessel arrivals in violation of ballast water management regulations has remained relatively small and steady. This has ranged from 3.3% during the first half of 2006 to 3.6% in 2004. It appears that the observed increases in the total volume of noncompliant ballast water discharged in California are likely due to the overall increases in the total number of vessels calling to the state, and to an increase in illegal discharges from high volume vessel types, such as bulkers and tankers. The CSLC is planning to improve compliance rates through increased enforcement. In 2007 the program plans to aggressively increase the issuance of citations and, if needed, monetary penalties.

Compliance through Field Inspections

Under PRC Section 71206, the CSLC assesses compliance of any vessel subject to the Act through a vessel inspection program. Currently, CSLC has two field offices, one in Southern California, and the other in Northern California. Inspectors boarded and inspected 14% (1357) qualifying voyages during Year 2004, 16% (1697) during Year 2005 and 17% (959) in the first half of Year 2006 (Table VII.1).

Table VII.1. Vessel inspections and associated information

	2004	***2005***	***1st half of 2006***
Qualifying Voyages	10077	10747	5635
Inspections Conducted	1357	1697	959
Inspected vessels discharging	75	373	175
# BW samples taken	146	157	61
Total Violations Cited	303	556	206
Administrative	284	522	178
Operational	19	34	28

During the inspection process, inspectors interview crew and review paperwork, including but not limited to ballast water reporting forms, ballast water logbooks and engine logbooks. If these items are not in order as required, the vessel is cited for an administrative violation. A salinity sample is taken at the top, middle and bottom of a subset of tanks intended for discharge in California. Any tank with a salinity reading below 29 PPT (parts per thousand) serves as a flag for a potential violation and the Inspector more closely scrutinizes paperwork and re-interviews vessel officer(s).

The majority of vessels inspected are found to comply with the Act. The majority of noted violations are associated with administrative components of the law (incomplete ballast water management plan, inaccurate ballast report forms, incomplete ballast tank logs, etc.). All inspected vessels found in violation of the California law are cited. A copy of the citation is given to the vessel crew and a copy is retained by CSLC. In addition, a copy of the violation and an enforcement letter is sent to the vessel owner. The vessel is then targeted for re-inspection upon its next visit to California waters.

While the percentage of inspections conducted annually has increased since 2004, CSLC continues to fall short of the requirement to inspect a minimum of 25% of all arriving vessels. In response, CSLC has submitted a budget change proposal for fiscal year 2007-2008, requesting additional field inspectors. That proposal is currently being considered by the Department of Finance.

Fee Submission

Under PRC Section 71215, the Board of Equalization (BOE) collects the fee from the owner or operator of each vessel that arrives at a California port or place from a port of place outside of California. BOE receives daily reports from the Los Angeles/Long Beach Marine Exchange listing actual arrivals from the following ports: Los Angeles/Long Beach, Port Hueneme, San Diego, and El Segundo. In addition, the Board receives two daily reports from the San Francisco Marine Exchange. An electronic and paper record of this information is maintained for reference and use by the BOE staff. The reports are reviewed to determine which arrivals are qualifying voyages and thus subject to the Fee. Additional analysis is necessary to assign the correct account numbers to these arrivals. Further, it must be determined if a notice of determination (billing) should be mailed or if the arrival should be reported on the fee payer's monthly returns (where applicable). In 2001, a return (self-reporting) process was initiated by BOE to reduce the overall number of billings, though not the amount of revenue collected. With the assistance of industry representatives, a return form was developed allowing the larger owner/operator/agents to self-report their vessel voyages.

There are currently 2,508 ballast accounts representing 7372 vessels registered with the BOE. On average, 120 new Ballast Registrations are added per month. In addition, an average of 150 accounts maintenance items (address changes, adding vessels to existing accounts, etc.) are processed per month. An average of 25 Ballast Accounts are closed out each month, and an average of 525 Ballast Water billings are mailed per month (Table VII.2). Compliance rate for fee submission exceeds 98%.

Table VII.2. Summary of Marine Invasive Species Fee Program.

Period of Activity	Voyages Billed	Voyages Reported (Note 1)	Total Voyages	Fees Billed	Fees Reported (Note 1)	Total Fees	Payments Received for Period (Note 2)
2000	5871		5871	2735534		2735534	2723981
2001	5263	510	5773	2105200	204000	2309200	2306992
2002	4608	921	5529	1378400	277200	1655600	1639458
2003	4668	1013	5681	933600	202600	1136200	1133732
2004	5699	1123	6822	2752200	535100	3287300	3248625
2005	6070	1156	7226	2830700	534700	3365400	3326187
Through August 2006	4200	768	4968	1680000	307200	1987200	1961363
TOTAL	**36379**	**5491**	**41870**	**$14,415,634**	**$2,060,800**	**$16,476,434**	**$16,340,338**

NOTES: Note 1: Returns are due at the end of the month following the period of activity.
Note 2: As a result of penalties and accrued interest for any one period, actual cash received may exceed amount originally billed.

VIII. RECENT PROGRAM ACCOMPLISHMENTS

Since 2004, MISP has completed several projects and reports which were mandated by the Act. CSLC convened technical advisory panels to address the issue of non-ballast NIS vectors and established recommendations on performance standards for the discharge of ballast water. Additionally, CSLC continues to collect information on available ballast water treatment technologies. While these projects have strengthened the knowledge and ability of MISP to prevent NIS introductions, challenges have surfaced which will need to be addressed.

The Coastal Ecosystems Protection Act of 2006 was recently signed into law, initiating a phased implementation of performance standards for the discharge of ballast water. Under this new law, some vessels will be required to treat ballast water before discharging in California by 2009, and all vessels will be subject to the law by 2016. As a result, CSLC will need to develop criteria and procedures for evaluating and monitoring treatment technologies. Staff expects to overcome several major hurdles related to the issue of ballast water treatment, enforcing standards for treatment, and identifying available treatment technologies.

Alternative Treatment Technologies

Ballast water exchange is considered an interim solution for NIS introductions from ballast water release. Ballast water exchange in mid-ocean can pose safety issues, delay voyages, and can vary in its effectiveness. The development of ballast water treatment (BWT) technologies is underway, but no alternative treatments have yet been approved by state, regional, or federal authorities. Most of these experimental systems are still undergoing additional refinement and evaluation, and their effectiveness at removing or eliminating NIS is still unclear.

An effective ballast water treatment technology must be able to function under a wide range of challenging conditions. They must not only be effective under variable environmental conditions such as temperature, salinity, nutrients and suspended solids, but also must function under difficult operational constraints including high flow-rates, high water volumes, and variable retention times (time ballast water is held in tanks). They must be capable of eradicating a variety of different organisms ranging from microscopic bacteria to free-swimming plankton.

In order to identify alternatives to ballast water exchange, PRC Section 71210 requires CSLC to sponsor a pilot program to evaluate BWT technologies, in consultation with the State Water Resources Control Board, a technical advisory group and the United States Coast Guard. Public Resources Code Section 71213 also allows the CSLC to support other research determined necessary to carry out the requirements of the law. The following is a brief review of BWT technologies. A more detailed report will be available in 2008 as required by the Coastal Ecosystems Protection Act.

CSLC evaluates BWT alternatives through: 1) collaborative research projects, 2) technical workgroups, and 3) participation with and examination of other programs involved with BWT technologies. Funding is provided for the installation and testing of promising treatment systems onboard operational vessels. Beyond collaborative research, Staff organize and participate in technical working groups of experts who specialize in fields such as marine ecology, biology, chemistry, and naval engineering.

Throughout these efforts, CSLC actively pursues information through other state, federal and global ballast water programs involved with BWT alternatives.

CSLC collaborates formally with the USCG on the testing of BWT alternatives to reduce redundancy, share information, and ensure that BWT technology evaluations occur in the most efficient manner possible. Research contracts funded by CSLC require applicants to participate in the USCG Shipboard Technology Evaluation Program (STEP), a federal program intended to encourage the development of ballast water treatment technologies. Owners and operators that are accepted into STEP may install and operate specific experimental BWT systems on their vessels. In order to be accepted, treatment technology developers must assess the efficacy of systems for removing biological organisms, residual concentrations of treatment chemicals, and water quality parameters of the discharged ballast water (USCG 2004).

Since 2005, CSLC staff have been active participants on several technical advisory workgroups that address the issue of testing and evaluation of ballast treatment systems. In June 2005, MISP staff were requested to participate in a multi-disciplinary workshop convened jointly by the Smithsonian Environmental Research Center and Portland State University to discuss strategies for evaluating ballast water treatment technologies. Most workshop participants were technical experts or scientists involved in ballast water research (toxicology, experimental design, ship operations, biology and ecology). The workshop produced a set of guiding principles to consider for the testing and evaluation of alternative treatment technologies that will be particularly useful as BWT standards are implemented at the state, federal and international levels (Ruiz et al. 2006).

The EPA Environmental Technology Verification Program

The objective of the Environmental Protection Agency's Environmental Technology Verification (ETV) program is to accelerate the development and marketing of environmental technologies, including ballast water treatment technologies. The USCG and the EPA have established a formal agreement to implement an ETV program

focused on ballast water management. The Naval Research Laboratory has in turn partnered with the USCG in the design and construction of an ETV Ballast Water Treatment System Test Facility in Key West, Florida. This land-based facility has been constructed with the goal of evaluating BWT technologies designed to eliminate NIS from ballast water.

In August 2006, CSLC staff participated in a technical workshop at the ETV Ballast Water Treatment Test Facility to address the development of testing protocols for experimental BWT technologies. A summary of that workshop is expected in mid-2007. Ultimately, it is hoped that the innovative research conducted at this facility can be used to develop technical procedures for approving ballast water treatment systems. As CSLC moves forward to evaluate the efficacy of BWT alternatives, the principles and conclusions learned through participation in these technical workgroups, as well as input from other national and international programs, will be considered and integrated into California's policies.

International Maritime Organization

The IMO has identified specific performance standards in the International Convention for the Control and Management of Ships' Ballast Water and Sediments of 2004. As a consequence, the IMO has begun developing an international approval process for ballast water management systems (IMO 2005). One document in particular, the Guidelines for Approval of Ballast Water Management Systems, has been used by CSLC to guide policy recommendations for ballast water treatment alternatives (Falkner et al. 2006). These guidelines specify pre-test evaluation of system documentation, test and performance of specifications for approval of ballast water management systems, environmental testing for approval of ballast water management systems, and sample analysis methods for the determination of biological constituents in ballast water (MEPC 2005). Although the treatment standards specified by the IMO Convention differ from those adopted by the State of California, the guidelines for the evaluation of ballast water treatment systems provide insight as California develops its own criteria and process to evaluate technologies.

Collaborative research between vessel owners, the USCG and CSLC to evaluate experimental treatment systems contribute valuable and necessary information as the implementation of policies related to BWT move forward. Participation in workgroups that bring together technology development, regulatory policies, biological research, and testing protocol concepts provides CSLC with information on how to best evaluate BWT alternatives. Lastly, evaluations conducted by other national and international programs offer helpful information on issues related to biological efficacy, environmental soundness, vessel and crew safety, and engineering integration. Further research and technical workshops should continue to address the most appropriate protocols for evaluating BWT systems in California.

Performance Standards

In response to the slow progress of ballast water treatment technology development and the need for effective ballast water treatment options, PRC Section 71204.9 required the California State Lands Commission to recommend specific performance standards for ballast water discharge to the State Legislature. Performance standards would set benchmark levels of organism discharge that a technology would be required to achieve for it to be deemed acceptable for use in California. The law directed CSLC to consult with the USCG and the SWRCB, and to consider recommendations provided by a technical advisory panel (PRC Section 71204.9).

CSLC staff convened a cross-interest, multi-disciplinary panel (Panel), and facilitated discussion over the selection of performance standards based upon the best available technology that is both economically achievable and designed to protect the beneficial uses of the waters of the State. Panel participants represented multiple groups including Portland State University, Moss Landing Marine Laboratories, The Smithsonian Environmental Research Center, San Francisco Bay National Estuarine Research Reserve, The Ocean Conservancy, The Bay Institute, Chevron Shipping, Matson Navigation Company, Pacific Merchant Shipping Association and several government agencies (See Performance Standards Advisory Panel Report 2006 for a complete list).

Goals of the advisory Panel meetings were to discuss criteria for the selection of ballast water performance standards and potential frameworks for their implementation. Topics of discussion included biological data on organism concentrations, theories on coastal invasion rates, other regulatory programs with proposed performance standards, and available information on treatment technologies. Each topic provided some level of insight and rationale during the discussions, however scientific and technological evidence was lacking to guide the selection of a particular standard. Recognizing the need for more information, participants voted to recommend a set of performance standards with an incremental review period. The standards were based on organism size class, and an implementation schedule according to vessel size class and construction date (see Figures VIII.1 and VIII.2).

Once the advisory panel process had concluded, CSLC moved forward to recommend performance standards to the State Legislature which considered the advisory panel recommendations. Staff consulted with SWRCB and attempted to consult with USCG (which was unsuccessful due to a USCG rulemaking process regarding performance standards). CSLC further considered the protection of beneficial uses, economic achievability, and technological feasibility. All provided some foundation for the development of recommendations, but all were severely limited in the extent to which they could direct the determination of a specific set of standards.

Because there was so little biological information to guide the determination of performance standards, Staff determined that zero discharge of NIS would be the most protective of State waters, and therefore should be the final performance standard. Until it was determined that final zero discharge standard could be reached, Staff recommended interim standards and an implementation schedule as listed in Tables VII.1 and VII.2. The standards recommended to the Legislature by the CSLC are identical to the standards recommended by a majority vote of the advisory panel.

Table VIII.1. Final staff recommendations described in the Performance Standards report from January 2006.

Organism Size Class (Units)	CSLC Staff Recommendations
> 50 μm (/m^3)	No detectable living organisms
10 - 50 μm (/mL)	10^{-2} organisms
< 10 μm (/100 mL)	10^3 for bacteria 10^4 for viruses Public health protective limits [1]
[1] 126 colony-forming-units per 100 milliliters of Escherichia coli, 33 colony-forming-units per 100 milliliters of Intestinal enterococci, 1 colony-forming-unit per 100 milliliters or 1 colony-forming-unit per gram of wet zoological samples for Toxicogenic Vibrio cholerae (serotypes 01 and 0139) Note: Final Performance Standard of zero detectable for all organism size classes by 2020 in the State of California	

Table VIII.2. Corresponding implementation schedule for interim performance standards described in the Performance Standards report from January 2006

Ballast water capacity	New vessels in this size class constructed on or after-	All other vessels in this size class beginning in
< 1500 metric tons	2009	2016
1500 – 5000 metric tons	2009	2014
> 5000 metric tons	2012	2016

Final recommendations were put forward to the Legislature by CSLC staff in a report produced in January of 2006 (Falkner et al. 2006). A complete list of all recommendations and the rationale behind them are explained in detail in that document. The following summarizes the most notable recommendations in the report:

- Adopt the Interim Performance Standards put forward by the Majority Panel Report.
- Adopt the Implementation Schedule proposed by Majority Panel Report and adopted in the IMO Convention for the interim standards.

- Adopt the Final Performance Standard of zero detectable for all organism size classes by 2020.
- Mandate initial and periodic reviews of treatment technologies and management practices to determine if options are available to meet or exceed the proposed standards by the required timeframes.

Since submission of the final report to the legislature in January 2006, the recommendations put forward by CSLC were incorporated into new legislation. The Coastal Ecosystems Protection Act of 2006 (SB 497) was passed by California lawmakers and signed by Governor Schwarzenegger in September 2006. This Act requires the CSLC to develop and adopt regulations that implement the recommended performance standards by January 2008.

Non-Ballast Vessel Vectors

As noted earlier, the primary ship-based mechanisms through which aquatic NIS can be transported to North America are ballast water and fouling (Ruiz et al. 2000a). Fouling forms as organisms attach to or associate closely with wetted surfaces. These surfaces can be human-constructed or natural, and can include substrates such as pier pilings, oil platform sub-structures, or tide pool rocks (Railkin 2004). The full "fouling community" includes the organisms that attach directly to surfaces such as barnacles and mussels, as well as microorganisms, and associated mobile organisms such as shrimp and crabs. If fouling forms on mobile structures such as ships, NIS can be transported as their "host" structure is moved from place to place. Thus, vessel fouling has been identified as one of the most important mechanisms for marine NIS introductions in several regions, including North America, Hawaii, and the North Sea (Ruiz et al. 2000a, Eldredge and Carlton 2002, Gollasch 2002).

The Act directed the MISP examine the risk of commercial ship-based vectors other than ballast water to release NIS in California, in consultation with the SWRCB, the USCG and a multidisciplinary TAG. Based on this analysis, the MISP was required to prepare a report for the Legislature recommending actions to reduce the discharge of

NIS through this/these mechanism(s). In early 2005, the MISP assembled a TAG that included representatives from the shipping industry, researchers, government agencies, and other interested parties. Participants included (but were not limited to) scientific experts on NIS ecology and vessel fouling from New Zealand, Hawaii, Oregon and the Smithsonian Environmental Research Center (SERC), a vessel maintenance manager for a commercial shipping company, and a representative from a multinational antifouling paint manufacturer.

Discussions began in May 2005 with a workshop co-facilitated by CSLC staff and the California Sea Grant Extension Program. Three additional CSLC TAG meetings were organized and facilitated by Staff between August and December 2005. Initial meetings focused on information sharing between stakeholder groups so considerations could proceed based upon the cross-disciplinary knowledge represented by the group. Subsequent discussions examined the hull husbandry practices of the commercial vessel fleet, environmental conditions and vessel behaviors that influence fouling, and the fouling management strategies that have been adopted or considered by other regions.

The most difficult challenge to evaluating NIS risk and for developing management recommendations was the limited amount of baseline information available on fouling and NIS across the types of vessels that regularly operate in California. In regions outside of California, it has been observed that a small minority of vessels exhibit exaggerated characteristics that facilitate fouling, and likely pose a high risk. These include vessels or platforms that travel at very slow speeds, spend extended periods immobile, and rarely clean or coat their hulls with antifouling paints designed to discourage fouling growth. Vessels with these profiles, however, are not characteristic of most of the fleet. There was little information on the potential posed by a majority of the fleet that conducts regular maintenance, spends little time in port, and travels and relatively swift speeds. There was also little information on how well the current maintenance practices of the majority fleet limit the transport and release of NIS.

The Commission therefore recommended actions aimed towards: 1) addressing high risk situations, and 2) building the information and tools needed to refine management in the future. To this end, major recommendations put forward included:

- Authorize the Commission to develop and adopt regulations to minimize NIS release, particularly from those vessels that pose a high risk.
- Expand biological research to characterize the NIS risk posed by commercial vessel fouling to California. In particular, expand biological research that may elucidate which vessels or vessel factors are indicative of an elevated risk.
- Collect information from vessels that call to California on those factors that influence fouling accumulation, such as vessel movement patterns and maintenance practices.

For a detailed background on the advisory panel discussions, Staff considerations, and the rationale behind the complete set of recommendations that were put forward to the state Legislature, please refer to the full report submitted in April of 2006 (Takata et al. 2006).

During October 2005, Staff moved forward with the recommendation to collect information from vessels calling to California on the vessel movement patterns and maintenance practices related to fouling accumulation. A voluntary “Hull Husbandry Survey” was developed and distributed to vessels, in conjunction with a survey mandated by the Clean Coast Act of 2005 on vessel graywater and blackwater capacity. The survey consisted of four targeted questions developed in consultation with members of the TAG with scientific expertise on vessel fouling and NIS.

All of the received survey forms have not yet been incorporated into a database. Results presented in this report represent very preliminary results of the Hull Husbandry Survey from a small, non-random subset of all forms received as of the end of September 2006 (over 1,100). As expected, most vessels indicated that they rarely spent long periods sedentary (Figure VIII.1), had entered dry dock relatively recently

(Figure VIII.2), and most appear to have renewed antifouling coating within the last 3 years (Figure VIII.3). In contrast, a small minority reported that they had spent at least one prolonged period stationary during the most recent 6 months, or had not entered dry dock or renewed their antifouling coating within the last 5 years. It is hoped that this information, coupled with biological studies on the extent and composition of fouling on commercial vessels arriving to California, will provide a better understanding of which vessels pose the highest risk for NIS introductions via this pathway, and will help guide the development of appropriate management solutions to minimize this risk. The final staff report on Commercial Vessel Fouling in California, and any additional updates on the project, can be found on the CSLC website (www.slc.ca.gov).

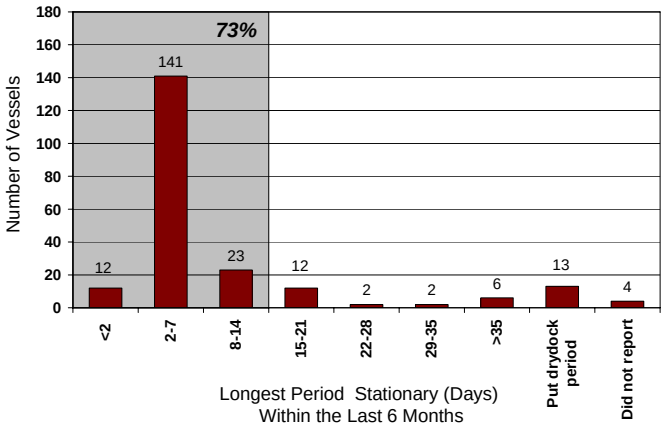

Figure VIII.1. Longest period stationary (days) within the last 6 months

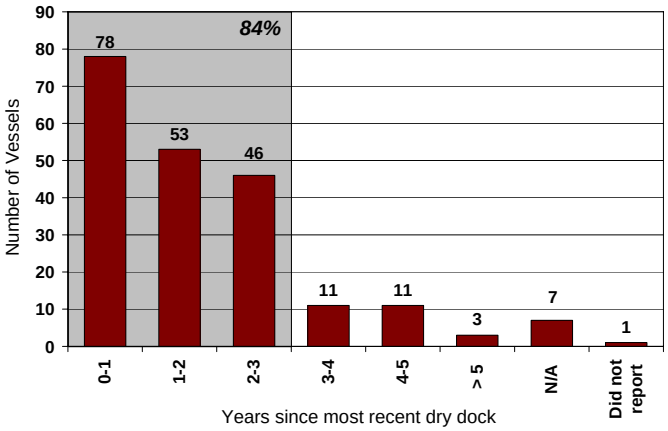

Figure VIII.2. Years since most recent dry dock

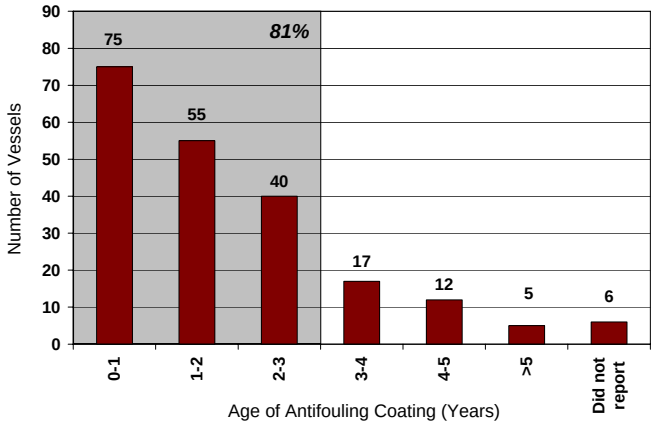

Figure VIII.3. Age of antifouling coating (years)

IX. FUNDED AND COLLABORATIVE RESEARCH

Hull Fouling

With funding from the MISP, the Aquatic Bioinvasion Research and Policy Institute, which combines SERC's marine expertise and Portland State University's freshwater expertise, is conducting a study to examine the potential for invasions to California through the fouling vector. As a critical step toward assessing the scope of hull fouling as a vector along the U. S. West Coast, the Aquatic Bioinvasion Research and Policy Institute conducted an analysis of shipping patterns and estimated the magnitude of underwater hull surface (wetted surface area, WSA) arriving to California, Oregon, and Washington ports. The analysis was based on a recent two-year period (July 2003 - June 2005). Using the specific dimensions of each arriving vessel, the WSA was calculated, providing a measure of potential colonizable area for biofouling organisms (analogous to discharge volumes for the BW vector). These results were summed to examine flux of WSA by vessel type and arrival port.

A total of 29,282 vessel arrivals were recorded to West Coast ports over two years, having an estimated WSA of 265.6 million m^2. Ships arriving from overseas (i.e., with a last port-of-call outside of the three western states) accounted for approximately two-thirds of the traffic, and one-third of arrivals were from coastwise voyages (with a

domestic last port of call). Vessels arrived from ports located around the globe, but most overseas arrivals came from the strongest trade links with Asian ports in the NW Pacific and from Alaska, British Columbia and Mexico in the NE Pacific.

Overall, containerships dominated both arrivals and WSA patterns, contributing more than other ship types. There were also differences among ship types in terms of mean WSA, frequency of arrival, voyage routes and destination ports. These differences may be especially relevant to hull fouling transfers of NIS because of the external nature of the vector. In addition, the magnitude of coastwise traffic highlighted the connectivity among West Coast estuaries, linking source and destination ports and creating opportunity for the spread of non-native organisms by ships. Models of maritime transport geography may prove useful for assessing and predicting hull fouling transfers of species. For example, the pendulum model of shipping, where ships traverse an ocean followed by several shorter trips to coastwise ports before a returning transoceanic voyage, fits West Coast containership traffic well. Along with domestic coastwise traffic, this may have implications for the secondary spread of NIS – particularly from San Francisco Bay, which is the most invaded bay in California, Oregon and Washington.

It is clear that invasions are resulting from hull fouling of ships, and this vector may rival ballast water, especially for coastwise transfers. Management options are not straightforward however, because data are lacking. Current management in other regions of the world is focused on stochastic occurrences, targeting vessels with limited husbandry and high port residence as a proxy for high-density hull fouling. While there is a solid rationale for this approach, it also includes a minute fraction (<1%) of all arrivals, and invasion risk associated with most vessel arrivals has not been characterized. An assessment of biofouling by vessel type and operation, as well as estimating associated rates (risk) of establishment, is a critical gap and priority for informing effective policy, to both minimize transfers of non-native species by ships' hulls and to protect natural marine and freshwater resources of Pacific states.

BWE Verification

Salinity measurements are currently the only available assessment tool for rapid evaluation of BWE. Unfortunately, it is extremely limited in value (Murphy et al. 2005). Ballast water taken up at one of many high salinity ports would register salinity readings comparable to those of the open ocean. Thus salinity measurements may not indicate whether an exchange had been conducted. Additionally, the effectiveness of BWE at removing organisms varies significantly between vessel types, voyages, and even between tanks on a specific vessel (MEPC 2003, Taylor and Bruce 2000). Current assessment tools may not provide data on whether compliance is being met.

CSLC has entered into an agreement with the Smithsonian Environmental Research Center (SERC) to test the application of Ballast Water Exchange verification (BWEv) methodology on vessel traffic arriving to ports along western North America. The goal of the project is to identify indicator parameters that can reliably discriminate between exchanged and unexchanged ballast water and develop a rapid diagnostic tool for onboard use by inspectors. This work is also being supported under agreements between the USCG and several foreign nations.

The project's scope is to investigate spatial and temporal variations in concentrations of seven trace elements (As, Ba, Mn, Mo, P, U, V) and chromophoric dissolved organic matter (CDOM) in: 1) Focal domestic source ports; 2) transects (lines of sampling locations) between the US west coast and points 80-nm offshore, and 3) transects parallel to the US west coast. Data are collected onboard research vessels, offshore capable fishing vessels and ships engaged in voyages of commerce, according to protocols developed by SERC (Murphy et. al. 2003, 2005). The aim of this research is to identify the chemical components of sea water that are specific to open ocean vs. coastal waters, and based upon this information, create a tool to help identify whether ballast water has been properly exchanged.

Thus far, 71 CDOM samples from the LA-LB port complex and 102 trace element samples from an offshore transect on a commercial vessel have been analyzed.

Remaining samples are in frozen storage at SERC and have been placed in the queue for processing. SERC will continue to receive shipments of water samples for storage and analysis after every field sampling event. Results of sample analyses are made available to CSLC as information is compiled.

Planning, logistics, and staff scheduling is underway for additional sampling at the focal port of LA-LB, including associated offshore transects. The offshore transects will combine one offshore transect perpendicular to the coast with a transect along the coast and will be conducted from a container vessel steaming from LA-LB to the Port of Oakland. The results of this additional research will greatly enhance our knowledge of patterns of offshore and coastal trace element and CDOM abundance.

Alternative Treatment Technology Pilot Projects

In 2005, a portion of MISP funds were allocated to support the shipboard installation and evaluation of an experimental BWT technology onboard an Integrated Tug/Barge, the *Moku Pahu* operated by Matson Navigation Inc. Partial funds were provided to install and evaluate a chlorine dioxide treatment system. Initial studies of this treatment technology were carried out in 2002, and results have shown this technology to effectively treat zooplankton, phytoplankton, and some microorganisms (Oviatt et al. 2002). CSLC finalized a funding contract and project timeline with Matson Navigation Inc. which required system evaluation according to the USCG's STEP. During the summer of 2006, Matson Navigation Inc. submitted an application to the STEP, and the project is currently under review by an independent review panel. A team of researchers from the University of Rhode Island are scheduled to evaluate the system in late 2006 or early 2007 (CSLC 2004).

CSLC has additionally allocated funds for another BWT technology installation and evaluation onboard an American Presidential Line (APL) vessel in 2007. This experimental technology treats ballast water through de-oxygenation, and uses low-sulfur inert gas to displace oxygen thereby creating a hypoxic (low oxygen concentration) environment that significantly decreases the survival of NIS. This system

also claims an added benefit of reducing corrosion within ballast water tanks under certain operating conditions (Tamburri et al. 2005). Staff is currently working with prospective researchers and APL to develop a formal contract and project scope.

X. OTHER RESEARCH ONGOING AND COMPLETED DURING 2004-2006

Efficacy of Ballast Water Exchange

CSLC staff will assist Dr. Colin Levings, of the Canadian Aquatic Invasive Species Network, with ballast water sampling on ships that are traveling from the San Francisco Bay area to Vancouver, British Columbia. The project will assess the survival of ballast water organisms on coastal voyages. The intent is to obtain samples at the start and end of the voyage from a specific tank and investigate survivorship of the various species.

CDFG Invasive Species Survey

Under the 2003 legislation that expanded the Marine Invasive Species Program to include coastwise traffic, the California Department of Fish and Game was required to do a baseline survey of outer coast habitats and add that data to the baseline previously established for NIS in the state's bays and harbors. The Department was also directed to conduct a monitoring program to determine whether new introductions have occurred since the original baseline was established. The CDFG's office of Oil Spill Prevention and Response (OSPR) has contracted with Moss Landing Marine Laboratories to conduct the outer coast surveys and the on-going monitoring effort.

The field investigation for the outer coast was done in 2004 and 2005 with taxonomic identification work extending through much of 2006. The survey covered 22 sites from Oregon to the Mexican border, focusing primarily on areas around the prominent coastal headlands. Given the vast expanse of the California coastline it was not possible to collect specimens from all locations. In an effort to limit the field work to a manageable number of sites, while still including a representative array of habitats and covering the 1100 miles of coastline, emphasis was placed on choosing sites most likely impacted by a discharge from ocean-going vessels traveling in near-shore waters. The

coastal headlands seemed to be areas that best fit these criteria, since these are areas where species from a ballast discharge would likely wash ashore and become established. This study plan may be modified in the future if results suggest that other sites should be included but seemed the most reasonable approach given the constraints of time and resources.

Intertidal and subtidal habitats were sampled at the headlands locations. At the time of this writing, taxonomic identification of the organisms collected has found approximately 26 nonindigenous species, 127 species considered cryptogenic (not demonstrably native or introduced), and 1112 species identified as native (Table IX.1). Introduced species across the state ranged from a low of one at Point Saint George, Shelter Cove, Bodega, Fitzgerald and Año Nuevo to a high of 8 species at Point Fermin. NIS were approximately 0.3% to 2.2% of the total species collected from each site. Cryptogenic species ranged from 9 to 44 species at each site, representing 5.1% to 10.6% of total taxa, while native species ranged from 99 to 250 at each site, representing 47.5% to 65% of total taxa collected. Please note that these numbers are approximate and may change as taxonomic identifications are further refined.

Table X.1. Approximate numbers of intertidal and subtidal species found

Species Type	Number of species
NIS	26
Cryptogenic	127
Native	1112

A summary of the study, including site selection criteria, field and lab methods and results will be posted to the CDFG/OSPR website by January 2007.

The on-going monitoring effort required by the 2003 statute was begun in May of 2005 with sampling in San Francisco Bay, and continues through 2006 with sampling in the remaining ports and harbors first visited during the 2000/2001 baseline survey. In San

Francisco, 120 sites were sampled including rocky intertidal, sandy intertidal, fouling and benthic soft bottom habitats.

Taxonomists are currently working with the specimens collected from the San Francisco Bay and expect to have identification work completed by early 2007. Identification of the samples taken from the remaining ports and harbors should be completed by mid-2007.

The California Department of Fish and Game has worked to collaborate where possible with other agencies and organizations conducting similar surveys for NIS in coastal waters, and to share data generated by these studies so that financial and personnel resources are maximized. One such collaboration has been with the U.S. Fish and Wildlife Service (USFWS). In 2005, USFWS conducted a survey for NIS in San Diego Bay and in the fresh water areas of the Sacramento/San Joaquin Delta. Moss Landing Marine Laboratory was the principle investigator for USFWS. The data generated for those areas will be added to the CDFG database of all NIS in the California coastal waters and, in exchange, the data generated by the CDFG surveys of the remaining areas of the coast will be shared with USFWS for use in their programs.

In addition, CDFG is funding a study of *Watersipora* (a bryozoan or 'moss' animal) and its spread along the coast. Genetic analysis will be done on this species to determine whether the various populations are related. From this, it will be possible to determine whether the population at each site was independently introduced or if they were spread from one or more sites of initial introduction to other coastal areas. During the coming year an effort will be made to initiate similar studies of other species. Such studies are needed to help answer the question about introduction pathways and the degree to which introduced species are spread from one area of the coast to another through some secondary vector.

The report on the outer coast investigation and the database of all NIS in coastal and estuarine waters can be found online at:
http://www.dfg.ca.gov/ospr/organizational/scientific/exotic/OSPR%20Report.pdf

XI. REVIEW OF CURRENT VESSEL VECTOR RESEARCH

Invasive Species

Recent research suggests that estuaries are particularly vulnerable to invasion due to multiple factors: 1) estuaries are frequently subject to intensive shipping and thus a high potential infection rate; 2) brackish, estuarine species (organisms that live in salinities between freshwater and full strength seawater) have a better chance of being transported alive than other species due to their physiological tolerances; 3) brackish systems have a low natural diversity of native species, and as such, more invasive species are able to establish; and 4) estuaries are subject to a two-sided pressure of species invasion from both ocean and inland waters (Nehring 2006). The West coast of North America is subject to additional invasion pressure because estuaries are geologically young, heavily altered by humans, and subject to numerous vectors. As a result, West coast estuaries are strikingly more invaded than the open coast (11% of invertebrate fauna is invasive vs. 1%, respectively). In contrast to estuaries, the open coast is more species rich (a measure of species diversity and abundance) and is correspondingly less invaded. This pattern of coastal invasibility is contrary to terrestrial ecology where native and invasive species richness is often positively correlated (Wasson et al. 2005).

Ballast Water Management

Global ballast water management is a complex endeavor that merges international regulation, ships' specific configurations, and ecological conservation. Throughout the world, the largest ports may receive over 100,000 vessel visits annually. These large ports then serve as hubs for over 500 smaller ports in 100 countries. This information emphasizes the need to consider the secondary transport of invasive species from large ports to smaller ports by vessels engaged in regional trade (Niimi 2004).

Researchers are investigating the use of new modeling techniques to develop ecological theories to quantify the risk of invasion from ballast water discharge (Drake et al. 2005a). The goal of this research is to help push scientifically defensible policy forward. These models generate an estimated risk of species establishment by combining existing models for population spread with known information about a broad range of taxonomic categories. The allowable volume of ballast discharge in these models is dependent on the acceptable level of risk (a societal decision), taxonomic groups of concern, and characteristics of the receiving environment. This model highlights the importance of having data on ballast water discharge volumes and specific location of ballast water release in predicting the risk of species establishment.

On a global basis, approximately 3500 million tons of ballast water is discharged annually. Tankers and bulk vessels account for the vast majority of ballast water release (37% tank, 39% bulk), and 85% of trade takes places in the northern hemisphere. Based upon these statistics and using models that take into account vessel transit time on the open ocean and a critical wave height of 3 m (above which ballast water exchange will not take place), Endresen et al. (2004) calculate that 7% of vessels on a global basis are not able to conduct exchange if one day is needed for exchange, and 30% of vessels are not able to exchange if two days are needed. These results also indicate that season influences a vessel's ability to conduct exchange on the open ocean due to wave and weather conditions.

Wonham et al. (2005a) also use models to investigate invasion risk from ballast water release. Research suggests that invasion risk is diminished by reducing, "the quantity, quality, and frequency of introduced individuals." Wonham et al. (2005a) created a model to optimize the reduction in invasion pressure through ballast water exchange. Depending on the species of concern, ballast exchange may be performed early, late or not at all during vessel transit in order to reduce invasion risk. This model indicates that ballast water exchange effectiveness varies by species of concern, location from shore, chemical oceanography, and timing of exchange during transit. The efficacy of exchange is not only affected by the aforementioned factors, but it is also influenced by

the method of exchange. Choi et al. (2005) determined that the abundance of zooplankton in ballast water that underwent empty-refill exchange was significantly lower than zooplankton abundance in tanks that underwent flow through exchange. This complex matrix underscores the need to consider alternative management strategies to complement ballast water exchange in order to reduce invasion risk.

Ballast Water Exchange Verification

Ballast water sampling for exchange verification is an important and a complex undertaking influenced by ship design, access to ballast water sampling points, and the variety of organisms present and their diverse behaviors (David and Perkovic 2004). Sampling method is dictated by the objectives of the study including whether ballast is sampled inflow (during ballast uptake), in tank, or in the discharge. Proper sampling is important to determining if ballast water has been exchanged, and new methods are in the works to help verify if exchange has occurred.

As mentioned previously, one new method of ballast water exchange verification examines different concentration of chemical water characteristics (tracers) between exchanged and unexchanged water (Murphy et al. 2004). This method shows promise, however, research is still necessary to determine nearshore boundaries where this type of analysis may not be able to discriminate between coastal and open ocean water sources (Murphy et al. 2006). A different approach to examining “safe” areas for ballast uptake, Japanese researchers are investigating the use of SeaWiFS (Sea-viewing Wide-Field-of-view Sensor onboard a SEASTAR satellite) to determine plankton concentrations in water surrounding a vessel (Kozai et al. 2006). Japanese researchers are investigating the utility of this research in reducing plankton concentrations in ballasted seawater.

Ballast Water Treatment Technologies

Ballast water exchange is an interim solution to reducing the risk of invasion through ballast water release. Ultimately, ballast water treatment technologies are necessary to eliminate this vector as a source of invasive species. The development of onboard

treatment systems is not without challenges, however. Treatment systems must be capable of killing interior “biofilms”, microorganisms, and diapausing eggs within ships’ ballast tanks. Biofilms are organic matrices of bacteria, microalgae, and protozoans found on the interior walls of ballast tanks. Biofilms may harbor pathogens and may present a risk of microbial invasion if cells are released into the water or if biofilms slough off during ballasting operations (Drake et al. 2005b). Dinoflagellate cysts may also be found in ballast water, sediments and biofilms. Toxic dinoflagellates are responsible for outbreaks of paralytic shellfish poisoning and similar diseases in coastal waters; however, the IMO discharge standards do not address small cysts (<50 micrometers). Vessels full of small cysts would be considered compliant with IMO standards. At this time, researchers are unsure if treatments will even be able to remove larger dinoflagellate cysts as required in the discharge standards (Doblin and Dobbs 2006). Additional research suggests that treatments should be applied to ballast water as close as possible to discharge because many of the aforementioned taxa can reproduce asexually in tanks and this could influence predictions of risk and control (Wonham et al. 2005b). More research and development will be necessary before these treatment technologies will be ready for commercial use.

NOBOBs

Vessels declaring No Ballast On Board (NOBOB), account for 90% of vessels entering the Great Lakes. In comparison, approximately 14% of ships arriving to Chesapeake Bay declared NOBOB (Drake et al. 2005c). In 2005, 10.5% of arrivals to CA declared NOBOB. NOBOBs are considered an invasion risk in the Great Lakes because of an unpumpable residual of water and sediments at the bottom of ballast tanks. In one study, 32% of 39 ships sampled were found to harbor resting stages of known NIS in their ballast sediments (Bailey et al. 2005a), although in a different study, only 0.05 % of collected resting eggs from these sediments were able to hatch (Bailey et al. 2005b). Nonetheless, NOBOBs are considered a potentially small but important vector for invasive species.

Treatment of NOBOBs with salt water may reduce the likelihood of AIS release into the Great Lakes. Flushing residual freshwater and sediments with open ocean water prior to entering the Great Lakes has been considered a method of reducing the number of freshwater organisms at the bottom of tanks (Duggan et al. 2005). The efficacy of salinity as a treatment, however, appears to be temperature dependent and works best at 20 C, as opposed to 10 or 30 C. Additionally, while salt water flushing was demonstrated to reduce active invertebrates in residual ballast water, exposure of resting eggs to saline water inhibited hatching but did not cease hatching once the eggs were returned to freshwater (Bailey et al. 2006).

XII. NEEDED RESEARCH

Expand and coordinate biological research directed towards characterizing the NIS risk posed by commercial vessel fouling with other federal and state agencies. The limited amount of scientific research on vessel fouling and NIS in California and the West Coast is the most prominent obstacle to a clear evaluation of the overall risk faced by the State. Existing studies have been conducted on limited numbers and types of vessels, in regions largely outside of North America. Though relative generalizations from these studies regarding factors that influence fouling likely apply to vessels operating in California waters, the magnitude of the NIS risk cannot be extrapolated to the State. For example, while it may be presumed that a vessel that travels at an average of 7 knots likely has more fouling than one that travels at 17 knots; it is not known how much fouling, how many NIS, or the level of NIS risk that may be presented on each.

A number of questions critical for the development of effective scientifically grounded management requirements remain. At a minimum, information is needed to address the most basic, but most important question: How many fouling organisms and how many NIS arrive to and move within California via vessel fouling? Such information is critical for a characterization of the NIS risk faced by California. When coupled with vessel maintenance and movement patterns linked to fouling accumulation, research would lay the foundation to fill additional information gaps such as which kinds of vessels harbor

notably more fouling than others, what criteria can be used to flag a potentially high risk vessel, and which vessels pose a negligible amount of risk. Answers to these kinds of management-based research questions can guide the formulation of preventative management actions in the future.

XIII. LOOKING FORWARD

As required by the Act, CSLC has completed several projects and reports since 2004. These projects have strengthened the knowledge and ability of CSLC to prevent NIS introductions, led to new legislation, and have increased agency responsibilities. They have also raised many new questions and challenges that will need to be addressed over the next two years in order for the MISP to fulfill new legislative directives and to continue to "move the state expeditiously toward the elimination of the discharge of nonindigenous species into the waters of the state".

Regulations for Performance Standards

Under California's Coastal Ecosystems Protection Act of 2006, CSLC is required to develop and adopt regulations that implement the recommendations in the final staff report on "Performance Standards for Ballast Water Discharges in California Waters" (Falkner et al. 2006). The performance standards will allow CSLC to move from evaluation of compliance via a process-based approach (vessel-reported ballast water exchange) to compliance with a numeric standard. The development of regulations, processes, and infrastructure for effective implementation of performances standards will be extensive. Much work is needed to develop rapid and reliable compliance verification tools, and CSLC is working with USCG, SERC, the National Research Laboratory and others on these issues.

Regulations Resetting the Fee

The California Coastal Ecosystems Protection Act of 2006 removed the 2010 sunset date for the Marine Invasive Species Act and expanded the responsibilities of CSLC and CDFG. As a result, it is expected that the Fee that supports this expanded and extended State Program will need to be increased. The Fee is currently set at

$400/voyage. Current law authorizes the Commission to set the Marine Invasive Species Control Fee at up to $1,000 for each vessel that arrives at a California port or place from a port or place outside of California (PRC Section 71215(b)(2)). A fee of $600/voyage based upon 7,200 qualifying voyages would generate $4.2 million per year. Based upon current budget projections this would cover the cost of the program until FY 2012-2013 at which time the Fund status would require reevaluation.

Protocols for Independent Review and Evaluation of Ballast Water Treatment Systems

Evaluating the performance of ballast water treatment technologies onboard ships, under realistic operational conditions, is a requirement of most ballast water management programs. However, the evaluation of treatment systems is difficult and costly. In the past, many different approaches have been used to evaluate prototype systems, making comparison between technologies difficult. The lack of standardization creates significant confusion about which approaches should be used to determine regulatory compliance. Despite these difficulties, standardization of a specific set of testing procedures and performance criteria will be essential as the State of California implements ballast water discharge standards.

Currently, CSLC requires BWT technology vendors to apply to USCG's Shipboard Technology Evaluation Program to be considered for state support. In consultation with USCG, CSLC intends to utilize a contractor to prepare a guidance document describing the specific procedures and criteria to be used in the evaluation of technical information and test results. The processes and procedures developed will in turn be integrated into formal procedures for official State approval of ballast water management systems as the implementation of performance standards progresses.

Review of Ballast Water Treatment Technologies

In accordance with the recently passed Coastal Ecosystems Protection Act, CSLC will review and evaluate the status of ballast water treatment technologies in order to determine if appropriate technologies or management options are available to achieve

interim performance standards. An initial review of the efficacy, availability, and environmental impacts of technologies will be complete in late 2007. The Commission will work with SWRCB, USCG, and an advisory panel to complete this review.

Improving Compliance

While the number of vessel arrivals continues to increase annually, the proportionate number of vessel arrivals in violation of ballast water management regulations has remained relatively small and steady, ranging between 3.3% during the first half of 2006 to 3.6% in 2004. Over the last 2.5 years, less than one percent of all ballast water carried into the waters of the State did not meet the management requirements as prescribed in the law. Though, the vast majority of these noncompliant ballast water discharges underwent some type of exchange, reducing the risk of NIS introductions. As vessel owners/operators transition from ballast water exchange to effective treatment technologies in response to the implementation of performance standards, the risk of NIS introductions posed by ballast water will decrease. During this transition period and beyond, CSLC will continue to address noncompliant vessels through outreach and education and the pursuit of enforcement action as necessary.

XIV. CONCLUSIONS AND RECOMMENDATIONS

Through a variety of forward looking and innovative management strategies, CSLC has continued to improve California's Marine Invasive Species Program over the past 2.5 years. Staff have not only worked to address gaps in compliance monitoring and enforcement actions, but MISP legislative reports have contributed to the strengthening of NIS-related policies. Reports completed since 2004 have been instrumental in the development of regulations to stem the transport of NIS in the ballast water of vessels operating within the Pacific Coast Region and legislation directing CSLC to adopt regulations on performance standards for ballast water discharges. Furthermore, MISP continues to play a role in collaboration with other agencies and organizations to better address ship-born NIS issues.

The focus of the CSLC Program will continue to be on protection, prevention, outreach and education, and solution-based actions. CSLC will continue to concentrate our available resources on working proactively with the regulated industry to achieve a high rate of compliance with required management practices, to minimize discharges of unmanaged water, and to reduce the risks of biological invasions.

Recommendations

Many of the recommendations provided in the CSLC 2005 Biennial Report (Falkner et al. 2005) and CSLC 2006 Report on Performance Standards (Falkner et al. 2006) were considered by the Legislature and included in the expansion of the State's Marine Invasive Species Program by the California Coastal Ecosystems Protection Act of 2006. The passage of this new legislation marks an exciting, yet extremely challenging phase in the evolution of the MISP. Many new management actions will be initiated in coming months including: regulations to reset the Program Fee, regulations for performance standards, the development of protocols for independent review of ballast water treatment systems, and periodic reviews of ballast water treatment technologies. In addition, the following legislative actions are recommended for the MISP to continue to effectively prevent or minimize the introduction of NIS in California waters:

Broaden the State Program to include the control and prevention of NIS release via commercial vessel fouling

The Act focuses on the prevention of NIS introduction through ballast water discharges. While the Act briefly mentions vessel fouling, it does not authorize CSLC to: (1) adopt regulations to prevent NIS introductions through vessel fouling; (2) establish mandatory reporting on maintenance practices and other fouling-related behaviors; or (3) impose penalties. This lack of explicit authority prevents CSLC from implementing management actions related to the vessel fouling vector. The adoption of this recommendation would lead to an increase in the cost of the CSLC Program associated with increased staff requirements for data entry, compilation, and analysis, as well as additional vessel inspections and monitoring.

Support research promoting technology development related to vessel fouling

Most commercial vessels minimize the accumulation of fouling on their submerged surfaces by having growth scraped off while the vessel remains in the water. However, in-water cleaning is one of several ways through which fouling NIS can be transferred from a vessel to a recipient port. This potential supports the need for developing technologies that can collect and contain debris from in-water cleaning activities. In addition to reducing NIS release, these technologies could provide operators an avenue to clean hulls without releasing toxic antifouling debris, and without placing a vessel in dry dock. A containment-based in-water cleaning technology could also provide a tool to handle emergency cases when a heavily fouled, high NIS risk vessel arrives to the State, and dry docks are not available. Prototype technologies are under development to contain both fouling debris and toxic antifouling paint residuals, however, none are currently available for commercial application.

Legislation should therefore facilitate the advancement of in-water cleaning technologies that collect and contain fouling debris. The long-term goal of these technologies would be to phase out non-contained in-water cleaning activities in California. Legislation should also facilitate the advancement of antifouling coatings that create little or no water quality impacts, and which are effective for preventing fouling

accumulation on vessels. The advancement of both of these technologies would fulfill the intent of the Act to move towards the elimination of NIS discharge into waters of the State in a manner that also addresses water quality problems that may currently be generated by the antifouling practices of vessels. Funds necessary to support such a research program could be obtained through three mechanisms: general funds, grants, or through the existing fees assessed on ships. The cost to the Commission Program could be as much as $500,000 annually.

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